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ABSTRACT

Instructional materials on tune-ups are provided for an auto mechanics course in the motor transportation technology program. Instructor's plans are provided for three units. Each unit consists of instructional and manipulative lessons. The format of an instructional lesson is as follows: the subject, aim, a listing of teaching aids and materials, a list of references, prerequisites, preparation of the learner through motivation, presentation of information (instructional topics/teaching points and student and teacher activities), application, verification and/or evaluation, summary, and suggested reading for students. Instructor's plans for manipulative lesson detail a task, its aim, tools and equipment, materials, teaching aids, references, prerequisites, checking standards, preparation of the learner through motivation, presentation of the skills (steps and key points), application, verification and/or evaluation, summary, and suggested readings for students. Information sheets, job sheets, and worksheets are also provided for each lesson. Topics covered in the lessons are engine condition diagnosis, automotive engine tune-up, and basic fundamentals of electricity. (YLB)

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# MOTOR TRANSPORTATION TECHNOLOGY
# AUTOMECHANICS
# TUNE-UP

## BLOCK VIII

A-VIII

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VIII-C-17(S) Service Fuel Tank for 1975 Ford and Mercury . . . . . . . . 823
VIII-C-17(J) Service Fuel Tank . . . . . . . . . . . . . . . . . . . . . . . . . 829
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VIII-C-17a(TS) Place Vehicle on Stands . . . . . . . . . . . . . . . . . . . . 833
VIII-C-17b(TS) Remove Fuel Tank . . . . . . . . . . . . . . . . . . . . . . . 837
VIII-C-17c(TS) Clean and Inspect Fuel Tank . . . . . . . . . . . . . . . . . 839
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| | | |
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| VIII-C-19(J) | Remove and Disassemble One Barrel Carburetor | 893 |
| VIII-C-19(TS) | Remove One Barrel Carburetor from Vehicle | 895 |
| VIII-C-19a(TS) | Disassemble Throttle Body Flange Assembly | 897 |
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| VIII-C-20(S) | Clean, Inspect, Repair, or Replace One Barrel Carburetor Parts | 903 |
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| VIII-C-20a(TS) | Inspect and Repair or Replace Parts on a One Barrel Carburetor | 911 |
| VIII-C-21(S) | Reassemble and Make Initial Carburetor Adjustment | 913 |
| VIII-C-21(J) | Reassemble and Make Initial Carburetor Adjustment | 921 |
| VIII-C-21(TS) | Assemble Throttle Body Flange Assembly | 923 |
| VIII-C-21a(TS) | Assemble One Barrel Carburetor Bowl Cover | 925 |
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VIII-A-1(I)

# INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | ENGINE CONDITION DIAGNOSIS |
| AIM: | THE STUDENT WILL BE ABLE TO FOLLOW PROPER TEST PROCEDURES AND PRELIMINARY CHECKS TO VALUATE THE VEHICLE OPERATING CONDITION AND DETERMINE WHETHER THE ENGINE NEEDS MECHANICAL REPAIR OR A TUNE-UP. |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T (AS REQUIRED) |
| REFERENCES: | *AUTOMOTIVE TUNE-UP AND DIAGNOSIS*, WETZEL, CH. 30<br>*AUTO SERVICE AND REPAIR*, STOCKEL, CH. 23<br>*AUTOMOTIVE MECHANICS*, CROUSE, CH. 26 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE SUCCESSFULLY COMPLETED MAJOR BLOCKS II, III, AND VII |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE WORD "DIAGNOSIS" MEANS AN INVESTIGATION OR ANALYSIS OF THE CAUSE OR NATURE OF A CONDITION, SITUATION, OR PROBLEM. TO THE ENGINE TUNE-UP MAN (DIAGNOSTICIAN), A HIGH DEGREE OF AUTOMOTIVE KNOWLEDGE ABOUT ENGINE OPERATION, FUNCTION, AND PRINCIPLES OF ELECTRICAL AND FUEL SYSTEMS, IS REQUIRED TO TEST AND ANALYZE AUTOMOBILE ENGINE PROBLEMS.

AS SOON AS A CAR LEAVES THE DEALER'S FLOOR IT BEGINS TO WEAR OUT. SATISFACTORY PERFORMANCE OF THE MODERN HIGH SPEED, HIGH COMPRESSION ENGINE DEPENDS ON PERIODIC CHECKS AND ADJUSTMENTS, AND THIS CAN NO LONGER BE DONE BY OUR HUMAN FACULTIES AS IN THE EARLY DAYS OF THE AUTOMOBILE.

THE DIAGNOSTICIAN MUST BE ABLE TO SET UP AND USE SENSITIVE TEST EQUIPMENT, IN A SEQUENCED ORDER; UNDERSTAND THE UNDERLYING THEORY BEHIND THAT EQUIPMENT AND THE REASON FOR USING IT; AND INTERPRET TEST EQUIPMENT READINGS AND COMPARE RESULTS WITH MANUFACTURERS' SPECIFICATIONS IN ARRIVING AT A CONCLUSION FOR SLUGGISH, SUBSTANDARD ENGINE PERFORMANCE.

THIS LESSON LIMITS ITSELF TO ENGINE DIAGNOSIS AND INCLUDES ONLY THE ENGINE AND THE SUPPORTIVE SYSTEMS AND UNITS NECESSARY FOR ITS PERFORMANCE.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION | 1. THE USUAL TYPE ENGINE USED IN AUTOMOBILES IS THE FOUR-STROKE, OR OTTO CYCLE, INTERNAL COMBUSTION GASOLINE ENGINE<br>2. THIS ENGINE DELIVERS A POWER STROKE TO THE CRANKSHAFT EVERY SECOND REVOLUTION<br>3. FIRST STROKE-INTAKE OR SUCTION STROKE<br>a. PISTON TRAVELS DOWNWARD<br>b. EXHAUST VALVE IS CLOSED, INTAKE VALVE OPEN<br>c. CHARGE OF AIR-FUEL MIXTURE (CHARGE) DRAWN IN<br>4. SECOND STROKE-COMPRESSION STROKE<br>a. INTAKE VALVE CLOSES, EXHAUST VALVE REMAINS OPEN<br>b. PISTON TRAVELS UPWARD COMPRESSING CHARGE<br>c. COMPLETES FIRST REVOLUTION<br>5. THIRD STROKE-POWER STROKE<br>a. CHARGE IGNITED BY ELECTRIC SPARK<br>b. COMBUSTION DRIVES PISTON DOWN<br>c. POWER IMPARTED TO ENGINE CRANKSHAFT<br>6. FOURTH STROKE-EXHAUST STROKE<br>a. PISTON TRAVELS UPWARD<br>b. PUSHES BURNED MIXTURE OUT OPEN EXHAUST VALVE<br>c. COMPLETES SECOND REVOLUTION<br>NOTE: THIS IS A VERY SIMPLE EXPLANATION OF ENGINE OPERATING PRINCIPLES. IN REALITY THE MODERN AUTOMOBILE IS MUCH MORE COMPLICATED<br>7. THE PURPOSE OF ENGINE DIAGNOSIS AND ENGINE TUNE-UP IS TO MAINTAIN A CONDITION WHEREBY THE ENGINE WILL DELIVER MAXIMUM POWER WITH MAXIMUM ECONOMY<br>8. TO OBTAIN MAXIMUM EFFICIENCY ALL WORKING PARTS MUST BE PERFORMING |

PROPERLY; IGNITION AND AIR-FUEL CHARGE MUST BE FINELY CONTROLLED

B. DIVISIONS OF DIAGNOSIS

1. THREE MAJOR REQUIREMENTS FOR ENGINE OPERATION ARE:
    a. COMPRESSION
    b. IGNITION
    c. CARBURETION
2. THREE MAJOR DIVISIONS FOR ENGINE DIAGNOSIS ARE THEREFORE:
    a. THE ENGINE
    b. THE ELECTRICAL SYSTEMS
    c. THE FUEL SYSTEM

1. THE ENGINE

1. THE TERM "ENGINE" REFERS TO THE CYLINDER BLOCK, CRANKCASE, OIL PAN, CYLINDER HEAD, AND VALVE COVER
2. THIS ALSO INCLUDES ALL THE INTERNAL WORKING PARTS, MECHANICAL MAKEUPS AND SEALS

2. ELECTRICAL SYSTEMS

1. THE BATTERY IS INCLUDED IN ALL ELECTRICAL SYSTEMS
2. THE STARTING CIRCUIT
3. THE CHARGING CIRCUIT
4. THE IGNITION SYSTEM
5. AUXILIARY CIRCUITS-LIGHTS AND ACCESSORIES

3. FUEL SYSTEM

1. COMPOSED OF FUEL TANK, FUEL PUMP, FILTER, CARBURETOR, AND INTERCONNECTING LINES
2. ALSO INCLUDES CONTROL LINKAGE AND CHOKE

C. SEQUENCE OF DIAGNOSIS

1. OBVIOUS SYMPTOMS OF ENGINE TROUBLE SUCH AS SMOKEY EXHAUST, CERTAIN ENGINE NOISES, ETC. ARE QUICKLY ANALYZED BY THE SERVICE MANAGER AND ROUTED TO THE SHOP FOR WORK
2. ENGINES THAT SHOW NO OBVIOUS SYMPTONS ARE ROUTED TO THE DIAGNOSTICIAN
3. THE FOLLOWING IS AN APPROXIMATE CHECKING ORDER WHEN THE CAUSE

FOR POOR ENGINE PERFORMANCE IS NOT KNOWN

a. BATTERY
b. STARTING CIRCUIT
c. SPARK PLUGS
d. COMPRESSION
e. DISTRIBUTOR
f. IGNITION TIMING
g. FUEL PUMP
h. IGNITION SECONDARY
i. CHARGING CIRCUIT
j. AIR CLEANER
k. MANIFOLD VACUUM
l. CARBURETOR
m. COOLING SYSTEM

NOTE: THE FOLLOWING TESTS ARE MADE ON THE VEHICLE. IF TEST RESULTS ARE NEGATIVE IT MAY BE NECESSARY TO REMOVE COMPONENT AND MAKE FURTHER TESTS

D. BATTERY

1. THE BATTERY IS USUALLY THE FIRST COMPONENT TO BE CHECKED FOR IT WILL HAVE A DIRECT OR INDIRECT EFFECT ON THE OTHER ENGINE SYSTEMS
2. THE FOLLOWING QUICK TESTS ARE CONDUCTED TO DETERMINE BATTERY CONDITION
   a. VISUAL INSPECTION
   b. HIGH RATE DISCHARGE TEST
   c. LIGHT LOAD TEST
   d. HYDROMETER TEST

NOTE: CONDUCT TESTS AS PER LESSON III-A-2(S)

E. STARTING CIRCUIT

1. VISUAL INSPECTION
2. STARTER AMPERAGE DRAW TEST
   a. AMPERAGE USED BY STARTER UNDER LOAD
   b. ALSO CALLED STARTER LOAD TEST
3. CRANKING VOLTAGE TEST
   a. TEST INSULATED CIRCUIT
   b. TEST GROUND CIRCUIT

4. SWITCH
   a. MECHANICAL FAILURE
   b. SAFETY LOCK OUT (AUTOMATIC TRANSMISSIONS)

NOTE: TEST PROCEDURES AS PER LESSON III-B-2(S)

F. MECHANICAL CONDITION

1. VISUAL INSPECTION
2. COMPRESSION TEST
3. CYLINDER LEAKAGE TEST
4. CRANKING VACUUM TEST

G. IGNITION SYSTEM

SHOW: TRANSPARENCY FIG. 350

1. SHARES RESPONSIBILITY WITH FUEL SYSTEM FOR MAKING ENGINE RUN
2. CONSISTS OF:
   a. COIL
   b. PRIMARY AND SECONDARY WIRING
   c. IGNITION SWITCH
   d. BALLAST RESISTOR (WHERE USED)
   e. DISTRIBUTOR
   f. SPARK PLUGS

NOTE: BATTERY IS PART OF IGNITION BUT IS DISCUSSED AS A UNIT BY ITSELF

1. COILS AND BALLAST RESISTOR

SHOW: TRANSPARENCY FIG. 342

1. COIL IS RELATIVELY TROUBLE FREE
2. PHYSICALLY INSPECT FOR LOOSE TERMINALS, POSITIVE CONTACTS. CHECK COIL TOWER FOR CRACKS, CARBON TRACKS
3. TEST COIL POLARITY WITH VOLTMETER
   a. CONNECT POSITIVE TO GROUND ON ENGINE
   b. TOUCH NEGATIVE LEAD TO SPARK PLUG TERMINAL OF NUMBER ONE CYLINDER
   c. RUN ENGINE AT IDLE SPEED
   d. VOLTMETER INDICATES UP-SCALE, COIL HAS NEGATIVE POLARITY

SHOW: TRANSPARENCIES FIGS. 343, 344, 349

4. TEST FOR AVAILABLE VOLTAGE, CURRENT DRAW, RESISTANCE
   a. TESTS TO BE PERFORMED AT COIL OPERATING TEMPERATURE
   b. USE RELIABLE TEST EQUIPMENT AND FOLLOW MANUFACTURER'S INSTRUCTIONS

- c. THESE TESTS WILL EXPOSE ANY SHORTS, OPENS THAT PHYSICAL INSPECTION MISSED

5. BALLAST RESISTOR MUST OFFER SPECIFIED RESISTANCE IN BATTERY-COIL CIRCUIT
   - a. TEST WITH VOLTMETER NEGATIVE LEAD TO COIL "B" TERMINAL; POSITIVE LEAD TO IGNITION SWITCH ACCESSORIES
   - b. JUMPER CABLE FROM "D" LEAD TO GROUND
   - c. TURN SWITCH ON, LIGHTS OFF, NOTE READING AND COMPARE WITH MANUFACTURER'S SPECIFICATIONS

2. DISTRIBUTION

SHOW: TRANSPARENCIES FIGS. 332, 336, 337, 338

1 INSPECT CAP
   - a. CAP TOWERS FOR CARBON TRACKS, CRACKS, BURNING
   - b. CHECK CARBON BUTTON (INSIDE) FOR BURNING, CRACKING
   - c. TERMINAL POSTS (INSIDE) WORN, GROOVED, OR BURNED

2. INSPECT ROTOR
   - a. COMPLETELY INSTALLED AND SEATED
   - b. TIP FOR EXCESSIVE WEAR, BURNING
   - c. INSULATED BODY FOR CRACKS
   - d. CONTACT SPRING FOR CONDITION, TENSION, WEAR

NOTE: WHENEVER DISTRIBUTOR CAP IS REPLACED, REPLACE ROTOR ALSO

SHOW: TRANSPARENCIES FIGS. 317, 319, 320, 323, 324, 325, 326, 327

3. INSPECT BREAKER POINTS
   - a. PITTED, BURNED, OR MISALIGNED
   - b. WORN RUBBING BLOCK
   - c. TOO WEAK OR TOO STRONG BREAKER ARM SPRING
   - d. SHORTED PIGTAIL OR CONNECTION

SHOW: TRANSPARENCIES FIGS. 321, 322

4. DWELL ANGLE SETTING
   - a. SET UP DWELL METER PER MANUFACTURER'S SPECIFICATIONS
   - b. RUN ENGINE AT IDLE SPEED
   - c. CHECK DWELL
   - d. ADJUST POINTS GAP AS REQUIRED

NOTE: IF ADJUSTMENT FAILS TO PRODUCE SPECIFIED DWELL, CAM MAY BE WORN, OR POINTS ARE WRONG FOR CAR

5. INSPECT SHAFT FOR WORN (ROUNDED) CAM LOBES; TOO MUCH PLAY IN BEARINGS

SHOW: TRANSPARENCY FIG. 315

6. INSPECT CONDENSER TO INSURE SOUND CONNECTIONS; WIRES FREE OF MOVING PARTS; RIGHT CAPACITY

NOTE: IT IS AN ACCEPTED PRACTICE TO REPLACE THE CONDENSER WHEN POINTS ARE REPLACED

7. ADVANCE MECHANISMS, BOTH VACUUM AND CENTRIFUGAL, MAY STICK, WEAR OUT, OR OTHERWISE BECOME DEFECTIVE
   a. TO CHECK VACUUM ADVANCE
      (1) DISCONNECT VACUUM ADVANCE LINE
      (2) RUN ENGINE AT 1200 RPM
      (3) NOTE POSITION OF TIMING MARK WITH TIMING LIGHT
      (4) CONNECT ADVANCE VACUUM LINE; TIMING MARK SHOULD ADVANCE AGAINST THE DIRECTION OF ENGINE ROTATION
   b. TO CHECK CENTRIFUGAL ADVANCE
      (1) DISCONNECT THE VACUUM ADVANCE LINE
      (2) RUN ENGINE SLOWLY FROM IDLE TO 4000 RPM
      (3) USE TIMING LIGHTS TO WATCH TIMING MARK
      (4) TIMING MARK SHOULD ADVANCE SMOOTHLY AGAINST ENGINE ROTATION

8. CHECK TIMING AFTER POINT GAP AND DWELL ANGLE HAVE BEEN CHECKED AND FOUND OKAY

NOTE: CHECK AS PER III-D-4a(TS)

3. SECONDARY WIRING AND SPARK PLUGS

1. SECONDARY WIRING ON MOST LATE MODEL CARS ARE OF HIGH RESISTANCE

SHOW: TRANSPARENCIES FIGS. 306 THROUGH 310

TYPE, CARBON IMPREGNATED FIBER WITH AN INSULATED COVER AND CANNOT WITHSTAND SHARP BENDING OR ROUGH TREATMENT

a. CHECK INSULATION FOR CRACKS, BURNED OR GLAZED AREAS
b. CHECK TERMINAL CONNECTION TO CENTER CORE
c. CHECK RESISTANCE WITH OHMMETER

NOTE: THIS TYPE CABLE HAS APPROXIMATELY 4000 OHMS RESISTANCE PER LINEAR FOOT

SHOW: TRANSPARENCIES FIGS. 293, 301, 304, 305

2. SPARK PLUGS SHOULD BE REMOVED AND VISUALLY CHECKED FOR:
   a. EROSION OF ELECTRODES
   b. CRACKED PORCELAIN INSULATOR
   c. ELECTRODE GAP (USE GAGE)
   d. BURNED OR LOOSE TERMINAL
3. TEST SPARK PLUG IN SPARK PLUG TESTER TO INSURE PLUG WILL DELIVER SPARK UNDER SPECIFIED PRESSURE

H. FUEL SYSTEM

1. SHARES RESPONSIBILITY WITH IGNITION SYSTEM FOR MAKING AUTOMOBILE RUN
2. BASIC FUNCTION IS TO DELIVER AIR-FUEL MIXTURE. IN THE PROPER MIX AND QUANTITY, TO THE CYLINDERS FOR OPTIMUM PERFORMANCE UNDER THE VARIED CONDITIONS
3. THE FUEL SYSTEM IS COMPOSED OF:
   a. FUEL TANK
   b. FUEL LINES
   c. FUEL FILTER
   d. PUMP
   e. CARBURETOR
   f. AIR FILTER
   g. CONTROL LIKAGE
   h. INTAKE MANIFOLD
4. IF FUEL SYSTEM IS SUSPICIONED TO BE MALFUNCTIONING, ONE OF TWO CONDITIONS MAY EXIST
   a. CARBURETOR IS NOT RECEIVING PROPER AMOUNT OF FUEL

   b. AIR-FUEL MIXTURE NOT IN PROPER PROPORTION WHEN DELIVERED TO COMBUSTION CHAMBER

5. MOST COMPONENTS OF FUEL SYSTEM ARE RELATIVELY TROUBLE FREE
   - a. VISUALLY INSPECT TANK FOR DENTS, LEAKS AT THE SEAMS AND DRAIN PLUG, AIR VENT OPEN
   - b. CHECK ALL FUEL LINE FITTINGS FOR TIGHT MAKEUP
   - c. CHECK LINES FOR PINCHED OR CRIMPED SPOTS
   - d. CHECK FUEL PUMP SEDIMENT CHAMBER AND FILTER. IF THESE ARE EXCESSIVELY DIRTY, THE FUEL TANK MAY NEED CLEANING

NOTE: IF ANY OF ABOVE FAULTS ARE EVIDENT, CLEAN, ADJUST, OR REPLACE BEFORE PROCEEDING

6. THE MOST LIKELY TO BE AT FAULT IN THE FUEL SYSTEM ARE THOSE COMPONENTS WITH WORKING PARTS
   - a. FUEL PUMP
   - b. CARBURETOR

1. FUEL PUMP

1. CHECK PUMP FOR FUEL DELIVERY
   - a. GROUND DISTRIBUTOR TERMINAL OF COIL WITH JUMPER CABLE
   - b. DISCONNECT FEED LINE AT CARBURETOR
   - c. PLACE A SUITABLE CONTAINER AT END OF LINE
   - d. CRANK ENGINE A FEW REVOLUTIONS

NOTE: IF NO GASOLINE OR ONLY A FEW DROPS FLOW, PUMP IS INOPERATIVE OR FEED LINE IS CLOGGED

   - e. CHECK FEED LINE FOR CLEARANCE

2. PRESSURE TEST PUMP
   - a. INSTALL SUITABLE PRESSURE GAGE BETWEEN FEEDLINE AND CARBURETOR IN SERIES
   - b. REMOVE GROUND FROM TERMINAL COIL AND START ENGINE

- c. FUEL PUMP PRESSURE SHOULD READ 3 TO 5 PSI AT SLOW IDLE
- d. SHUT ENGINE OFF AND OBSERVE GAGE
- e. PRESSURE "LEAKDOWN" SHOULD NOT BE MORE THAN 1/2 LB. IN 20 SECONDS

NOTE: IF FUEL PUMP PRESSURE IS BELOW MINIMUM PUMP SHOULD BE REPLACED

3. IF APPROPRIATE PRESSURE GAGE IS NOT READILY AVAILABLE, ALTERNATE TESTS MAY BE CONDUCTED AS PER LESSON VII-C-1(I)

2. CARBURETOR

1. POOR CARBURETOR PERFORMANCE IS USUALLY CAUSED BY:
    - a. INSUFFICIENT AIR INTAKE
    - b. INSUFFICIENT FUEL INTAKE
    - c. IMPROPER AIR-FUEL MIX TO MEET THE PROPER REQUIREMENTS OF ENGINE RPM
2. THE CARBURETOR NOT ONLY MIXES GASOLINE AND AIR INTO VAPOR FORM, BUT REGULATES THE MIXTURE FOR DIFFERENT ENGINE NEEDS SUCH AS STARTING, IDLING, ACCELERATION, AND CRUISING
3. POOR CARBURETION IS EVIDENCED THROUGH SEVERAL INDICATORS
    - a. ENGINE WON'T START PROPERLY
    - b. ROUGH IDLING
    - c. STUMBLING ACCELERATION
    - d. POOR HIGH SPEED PERFORMANCE
4. ENGINE HARD TO START
    - a. REMOVE AIR CLEANER AND CHECK ACCELERATING PUMP DISCHARGE STREAM SUFFICIENT
    - b. CHECK, CLEAN, OR REPLACE AIR FILTER
    - c. CHECK CHOKE OPERATION
5. ROUGH IDLING CAN BE QUICKLY CHECKED BY TURNING IDLE ADJUST-

20

MENT SCREW TO SEE IF IDLE SMOOTHES OUT

6. STUMBLING ACCELERATION IS USUALLY DUE TO DIRT OR WATER IN THE SYSTEM
   a. AFFECTING CHECK VALVE OR ONE OF THE SMALL JETS IN LOW SPEED CIRCUIT
   b. CHECK BY SLOWLY INCREASING ENGINE RPM. IF ENGINE DOES NOT INCREASE SMOOTHLY, LOW SPEED CIRCUIT IS MALFUNCTIONING
7. CHECK FOR POOR HIGH SPEED PERFORMANCE:
   a. "REV" ENGINE TO MID-RANGE RPM
   b. SLOWLY COVER PART OF CARBURETOR AIR HORN WITH HAND
   c. ENGINE SPEED SHOULD INCREASE SLIGHTLY
   d. IF ENGINE DOES NOT SPEED UP SOMEWHAT HIGH-SPEED CIRCUIT IS WORKING IMPROPERLY
8. OTHER INDICATIONS OF CARBURETOR TROUBLE ARE:
   a. EXCESSIVE FUEL CONSUMPTION CAUSED BY HIGH FLOAT LEVEL, STICKING FLOAT OR FLOAT NEEDLE VALVE, WORN JETS AND NOZZLES, IDLE TOO RICH, LEAKING CARBURETOR
   b. SLOW ENGINE WARM UP COULD BE CAUSED BY DEFECTIVELY OPERATING CHOKE
   c. BACKFIRING CAUSED BY TOO "RICH" OR "LEAN" A FUEL MIXTURE

I. CHARGING CIRCUIT

NOTE: REVIEW STAGE II, LESSON III-C-5(I)

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT ARE THE FOUR STROKES OF ENGINE OPERATION AND WHAT DOES EACH STROKE DO?

    1. SUCTION STROKE-PISTON TRAVELS DOWN, DRAWS IN AIR-FUEL MIXTURE
    2. COMPRESSION STROKE-PISTON TRAVELS UP COMPRESSING CHARGE
    3. POWER STROKE-CHARGE IS IGNITED DRIVING PISTON DOWN IMPARTING POWER TO ENGINE CRANKSHAFT
    4. EXHAUST STROKE-PISTON TRAVEL UP, PUSHES BURNED MIXTURE OUT EXHAUST VALVE

2. WHAT ARE THE THREE REQUIREMENTS FOR ENGINE OPERATION?

    1. COMPRESSION
    2. IGNITION
    3. CARBURETION

3. WHAT ARE THE THREE BROAD DIVISIONS FOR ENGINE DIAGNOSIS?

    1. ENGINE (MECHANICAL)
    2. ELECTRICAL SYSTEMS
    3. FUEL SYSTEMS

4. NAME THREE ELECTRICAL CIRCUITS OR SYSTEMS VITAL TO CONTINUED ENGINE OPERATION.

    1. STARTING CIRCUIT
    2. IGNITION SYSTEM
    3. CHARGING SYSTEM

5. WHY IS THE STORAGE BATTERY THE FIRST MAJOR COMPONENT CHECKED IN ENGINE DIAGNOSIS?

    THE STORAGE BATTERY FURNISHES INITIAL CURRENT FOR STARTING THE ENGINE. ALSO USED EXTENSIVELY IN CHECKS REQUIRING TEST EQUIPMENT.

6. WHAT IS THE FIRST CHECK CONDUCTED ON THE CHARGING CIRCUIT USING TEST EQUIPMENT?

    VOLTAGE OUTPUT TEST

7. WHY IS THIS TEST CONDUCTED ON THE CHARGING SYSTEM FIRST?

    THIS TEST INDICATES WHETHER CHARGING SYSTEM IS FUNCTIONING AS IT IS INTENDED.

8. NAME THE COMPONENTS OF THE IGNITION SYSTEM EXCLUSIVE OF THE BATTERY.

THE IGNITION SWITCH, IGNITION COIL, IGNITION DISTRIBUTOR, SPARK PLUGS, WIRING PRIMARY AND SECONDARY

9. WHAT OTHER PART IS USUALLY REPLACED WHEN BREAKER POINTS ARE REPLACED?

CONDENSER

10. WHAT ARE THE TWO TYPES OF ADVANCE MECHANISMS INCORPORATED IN IGNITION DISTRIBUTORS?

CENTRIFUGAL AND VACUUM

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

MULTIPLE CHOICE:

1. THE PURPOSE OF THE AMPERAGE DRAW TEST ON THE IGNITION SYSTEM IS TO DETERMINE: b

   a. THE STATE OF BATTERY CHARGE
   b. IF CURRENT DRAW FALLS WITHIN SPECIFICATION
   c. IF RATED CAPACITY OF STARTING MOTOR IS SUFFICIENT
   d. IF BALLAST RESISTOR IS FUNCTIONING PROPERLY

2. THE CYLINDER COMPRESSION TEST IS USED TO DETERMINE: d

   a. CONDITION OF PISTON RINGS
   b. MAXIMUM COMPRESSION OF CYLINDER STROKE
   c. WHETHER OR NOT VALVE SEATS ARE FAULTY
   d. WHETHER OR NOT CYLINDER CAN HOLD COMPRESSION

3. THE TACHOMETER MEASURES: b

   a. P. S. I.
   b. R. P. M.
   c. M. P. H.
   d. T. P. I.

4. IGNITION TIMING IS CHECKED WITH A: c

   a. TACHOMETER
   b. DYNAMOMETER
   c. STROBOSCOPE
   d. FLEXISCOPE

5. THE TEST EQUIPMENT MOST USED TO CHECK HIGH RESISTANCE IN THE AUTOMOBILE'S ELECTRICAL SYSTEM IS THE: a

   a. VOLTMETER
   b. OHMMETER
   c. AMMETER
   d. DWELL METER

6. THE NORMAL COLOR FOR IGNITION POINTS WOULD BE: c

   a. DEEP BLUE
   b. REDDISH BROWN
   c. DULL GREY
   d. METALLIC SILVER

7. CAM ANGLE OR CAM DWELL IS THE: d

   a. NUMBER OF DEGREES OF CAM ROTATION DURING THE TIME THE POINTS ARE OPEN
   b. ANGLE AT WHICH THE RUBBING BLOCK CONTACTS THE CAM
   c. THE DISTANCE BETWEEN THE LOBES OF THE CAM
   d. NUMBER OF DEGREES OF CAM ROTATION FROM THE TIME THE POINTS CLOSE UNTIL THEY OPEN

8. SPECIFIC GRAVITY OF BATTERY ELECTROLYTE IS CHECKED WITH A: b

   a. VOLTMETER
   b. HYDROMETER
   c. AMMETER
   d. OHMMETER

9. WHEN CONDUCTING TESTS, THE STARTER SHOULD NOT BE OPERATED FOR MORE THAN _____ WITHOUT WAITING TWO MINUTES FOR COOLING OFF. b

   a. 5 SECONDS
   b. 20-30 SECONDS
   c. 1 MINUTE
   d. 1 1/2 MINUTES

10. IN A LOGICAL SEQUENCE OF ENGINE DIAGNOSIS, THE FOLLOWING WOULD BE CHECKED FIRST: d

   a. MANIFOLD VACUUM
   b. IGNITION TIMING
   c. CARBURETOR
   d. SPARK PLUGS

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE USUAL TYPE ENGINE USED IN AUTOMOBILES IS THE FOUR-STROKE, INTERNAL COMBUSTION, GASOLINE ENGINE.

THERE ARE THREE MAJOR REQUIREMENTS FOR OPERATION OF THIS ENGINE:

1. COMPRESSION
2. IGNITION
3. CARBURETION

THESE THREE REQUIREMENTS MUST BE FINELY CONTROLLED AND REGULATED FOR PEAK PERFORMANCE AND ECONOMY OF THIS ENGINE. THE MINUTE AN AUTOMOBILE LEAVES THE DEALER'S FLOOR IT BEGINS TO WEAR.

SATISFACTORY PERFORMANCE OF TODAY'S HIGH SPEED, HIGH COMPRESSION ENGINES DEPENDS ON PERIODIC CHECKS AND ADJUSTMENTS AND/OR REPLACEMENT OF THE WORN PARTS. THE AUTOMOBILE DIAGNOSTICIAN MUST POSSESS A HIGH DEGREE OF KNOWLEDGE ABOUT ENGINE OPERATION AND THE PRINCIPLES OF THE ELECTRICAL AND FUEL SYSTEMS AND MUST USE THIS KNOWLEDGE IN DIAGNOSING ENGINE MALFUNCTIONS. ONE MUST ALSO BE ABLE TO SET UP AND USE SENSITIVE TEST EQUIPMENT AND INTERPRET THESE TEST RESULTS IN DETERMINING THE CAUSE OF MANY MALFUNCTIONS.

SINCE THERE ARE THREE MAJOR REQUIREMENTS FOR ENGINE OPERATION, DIAGNOSIS IS DIVIDED INTO THREE DIVISIONS:

1. ENGINE (MECHANICAL)
2. ELECTRICAL SYSTEMS
3. FUEL SYSTEM

THERE IS ALSO A LOGICAL ORDER OR SEQUENCE IN TESTING ENGINE MALFUNCTIONS IF TROUBLE IS NOT OBVIOUS. ONE SUGGESTED ORDER FOR CHECKING MALFUNCTIONS IS AS DISCUSSED IN THE LESSON.

FIRST; THE BATTERY SHOULD BE CHECKED AND IN GOOD CONDITION AS MANY OTHER TESTS REQUIRE CURRENT DRAW ON THE BATTERY, PLUS ALL ELECTRICAL CIRCUITS START AND END WITH THE BATTERY.

SECOND; CHECK THE STARTING CIRCUIT TO INCLUDE VISUAL CHECK OF ALL COMPONENTS FOR CONNECTIONS. PERFORM STARTER LOAD TEST AND CRANKING VOLTAGE TEST.

THIRD; CHECK ENGINE CYLINDER FOR COMPRESSION AND/OR VACUUM.

FOURTH; CHECK IGNITION SYSTEM. CHECK SPARK PLUGS FOR CONDITION AND ADEQUATE SPARK DELIVERY. CHECK DISTRIBUTOR POINTS, CONDENSER, CAM OR DWELL ANGLE, ROTOR AND CAP FOR CONDITION, PROPER

ADJUSTMENT. CHECK COIL AND BALLAST RESISTOR FOR AVAILABLE VOLTAGE AND PRIMARY AND SECONDARY WIRING FOR CONDITION AND FUNCTION.

FIFTH; CHECK FUEL SYSTEM LINES OPEN, CONNECTIONS GOOD AND FILTERS CLEAN; FUEL PUMP DELIVERING SUFFICIENT FUEL; CARBURETOR FUNCTIONING PROPERLY AND MANIFOLD VACUUM ADEQUATE.

THESE CHECKS ARE ALL MADE ON THE VEHICLE AS COMMONLY PRACTICED IN AUTOMOTIVE SERVICE. WHEN A COMPONENT IS FOUND MALFUNCTIONING IT SHOULD BE REMOVED AND REPAIRED OR REPLACED.

SUGGESTED READING FOR STUDENTS:

AUTO SERVICE AND REPAIR, STOCKEL, CH. 23
AUTOMOTIVE MECHANICS, CROUSE, CH. 27

THE NEXT LESSON IS: VIII-B-1(I), "AUTOMOTIVE ENGINE TUNE-UP"

# INFORMATION SHEET
# ON
# IGNITION SYSTEM

SUBJECT: Isolating Ignition Problems on the Vehicle

## INTRODUCTORY INFORMATION:

At times it is more expedient to perform ignition system tests on the vehicle in order to save time and cash outlay for the customer and perform needed service for the vehicle in a more effective and efficient manner.

Performing tests, adjustments, or repairs for the ignition system is to cause the engine to operate with maximum acceleration, power, and economy of fuel. Too, a good operating engine will maintain the required exhaust emission levels. When performing tests, adjustments, and repairs for the ignition system it is essential to follow the procedures and specifications laid down by the manufacturer. Refer to the master parts catalog for parts usage and interchangeability before replacing a distributor or a component part for a distributor.

## GENERAL INFORMATION

The ignition system consists of a primary (low voltage) and a secondary (high voltage) circuit.

The primary circuit consists of the:

1. Battery
2. Ignition switch
3. Primary circuit resistance wire
4. Primary windings of the ignition coil
5. Breaker points
6. Condenser

The secondary circuit consists of the:

1. Secondary windings of the ignition coil
2. Distributor rotor
3. Distributor cap
4. High tension (spark plug) wires
5. Spark plugs

When the breaker points are closed, current flows from the battery through the ignition switch to the primary windings in the coil, then to ground through the closed breaker points. When the breaker points open, the magnetic field built up in the primary windings of the coil moves through the secondary windings of the coil, producing high voltage. High voltage is produced each time the breaker points open.

The high voltage flows through the coil high tension lead to the distributor cap where the rotor distributes it to one of the spark plug terminals in the distributor cap. This process is repeated for every power stroke of the engine.

Ignition system troubles are caused by a failure in the primary and/or the secondary circuit; incorrect ignition timing; or incorrect distributor advance. Circuit failures may be caused by shorts, corroded or dirty terminals, loose connections, defective wire insulation, cracked distributor cap or rotor, defective distributor points, fouled spark plugs, or by improper dwell angle.

If an engine's starting or operating trouble is attributed to the ignition system, start the engine and verify the complaint. On engines that will not start, be sure there is gasoline in the fuel tank and that fuel is reaching the carburetor. Then locate the ignition system problem by an oscilloscope test or by spark intensity test.

## Primary and Secondary Spark Intensity Test

Trouble Isolation. Connect an auxiliary starter switch into the starting circuit. Remove the coil high tension lead from the distributor cap tower. Turn the ignition switch to the on position. Use high tension wire pliers and hold the distributor end of the coil high tension lead approximately 3/16 inch from a cylinder head or any other good ground and crank the engine over with the auxiliary starter switch.

If the spark is good, the trouble lies in the primary circuit.

If there is no spark or a weak spark, the trouble is in the secondary circuit, coil to distributor high tension lead, or the coil.

Primary circuit. A breakdown or energy loss in the primary circuit can be caused by: defective primary wiring or loose or corroded terminals; burned, shorted, sticking, or improperly adjusted breaker points; or an open or shorted coil or condenser.

A complete test of the primary circuit consists of checking the circuit from the battery to the coil, resulting in hard starting and poor performance.

To isolate a trouble in the primary circuit, use a voltmeter and perform the following tests; battery to coil; starting ignition circuit; resistance wire; coil to ground; or breaker points.

Secondary circuit. A breakdown or energy loss in the secondary circuit can be caused by: fouled or improperly adjusted spark plugs; defective high tension wiring; or high tension leakage across the coil, distributor cap, or rotor resulting from an accumulation of dirt.

To check the spark intensity at the spark plugs, thereby isolating an ignition problem to a particular cylinder, proceed as follows:

CAUTION: This test is not to be performed with an electronic ignition system.

Check the spark intensity of one spark plug wire at a time. Disconnect a spark plug wire. Install a terminal adapter in the terminal of the wire to be checked. Use high tension wire pliers and hold the adapter approximately 3/16 inch from the exhaust manifold or any good ground. Crank the engine over with an auxiliary starter switch. The spark should jump the gap regularly. If the spark intensity of all the wires is satisfactory, the coil, condenser, rotor, distributor cap, and secondary wires are probably satisfactory.

If the spark is good at only some wires, check the resistance of those particular leads.

If the spark is equal at all wires, but weak or intermittent, check the coil, distributor cap, and the coil to distributor high tension wire. The wire should be clean and bright on the conducting ends and on the coil tower and distributor sockets. The wire should fit snugly and be bottomed in the socket.

Battery to coil voltmeter test. Connect a voltmeter between the positive post of the battery and the primary terminal of the coil. Connect a jumper wire from distributor terminal of the coil to a good ground on the distributor housing. All lights and accessories are to be off. Turn the ignition switch to the on position. If the voltmeter reading is between 4.5 and 6.9 volts, check the following:

The battery and cables for loose connections or corrosion. The primary wiring for worn insulation, broken strands, and loose or corroded terminals.

If the voltmeter reading is less than 4.5 volts, the ignition resistance wire should be replaced.

Check the starter relay to ignition switch for damage.

Starting ignition circuit voltmeter test. Connect a voltmeter between the positive post of the battery and the primary terminal of the coil. Disconnect and ground the coil to distributor high tension lead at the distributor. The ignition switch is to remain in the off position. Use an auxiliary starter switch and crank the engine over. Observe the voltage drop on the voltmeter.

If the voltage drop is 0.4 volt or less, the starting ignition circuit is satisfactory.

If the voltage drop is greater than 0.4 volt, clean and tighten the terminals in the circuit or replace the wiring as necessary.

Ignition switch voltmeter test. Locate the point at which the ignition switch lead can be separated from the wiring harness. Refer to the vehicle wiring diagram to identify the ignition switch lead. The wiring harness will be color coded. Fabricate a jumper wire by pulling some insulation from the center of the wire. Affix a female connector to end of the jumper and a male connector to the opposite end. Insert the male connector in the harness and the female end on the switch lead. Connect a voltmeter between the bared part of the jumper and the primary terminal of the coil. Install a jumper wire from the distributor terminal of the coil to a good ground on the distributor body. All accessories and lights are to be off. Turn the ignition switch to the on position.

If the voltmeter reading is 0.3 volt or less, the ignition switch and the relay to switch wire are satisfactory.

If the voltmeter reading is greater than 0.3 volt, either the ignition switch and/or the wire is damaged.

Resistance wire voltmeter test. Locate the point at which the ignition switch lead can be separated from the wiring harness. Refer to the vehicle wiring diagram to identify the ignition switch lead. The wiring harness will be color coded. Fabricate a jumper wire by peeling some insulation from the center of the wire. Affix a female connector to one end of the jumper and a male connector to the opposite end. Insert the male connector in the wiring harness, and connect a voltmeter between the female end of the jumper and the primary terminal of the coil. Install a jumper wire from the distributor terminal of the coil to a good ground. All accessories and lights are to be off. Turn the ignition switch to the on position.

If the voltmeter reading is between 6.6 and 4.5 volts, the resistance wire is satisfactory.

If the voltmeter reading is greater than 6.6 volts or less than 4.5 volts replace the resistance wire. Disconnect all test equipment and connect all leads to proper terminals.

Coil to ground voltmeter test. Connect a voltmeter between a good ground and the primary terminal of the coil. Lift distributor cap, turn engine over, and close the breaker points. All lights and accessories are to be off. Refasten distributor cap in position on the distributor. Turn the ignition switch to the on position.

If the voltmeter reading is 0.25 volt or less, test the voltage drop between each of the following:

1. The coil and the breaker point connections of the coil to distributor primary wire.
2. The movable breaker point and the breaker plate.
3. The breaker plate and the distributor housing.

Disconnect the test leads and make all necessary connections.

Coil test. Check the amperage draw both with the engine idling and stopped. These checks should fall within specifications.

Other checks for the coil are to be made on a coil tester following the manufacturer's instructions. Check for ohms resistance both primary and secondary.

Secondary (high tension) wires resistance test. The secondary wires include the wires connecting the distributor cap to the spark plugs and the wire connecting the center terminal of the distributor cap to the center terminal of the ignition coil.

These wires are the radio resistance type which filter out the high frequency electrical impulses that are the source of ignition noise interference. The resistance of each wire should not exceed 1000 ohms per inch. When checking the resistance of the wires or setting ignition timing, do not puncture the wires with a probe. The probe may cause a separation in the conductor.

When removing the wires from the spark plugs, grasp and twist the moulded cap, then pull the cap off the spark plug by hand only. Do not pull on the wire because the wire connection inside the cap may become separated or the insulator may be damaged.

# INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | ISOLATE IGNITION PROBLEMS ON THE VEHICLE |
| AIM: | THE STUDENT WILL BE ABLE TO DIAGNOSE AUTOMOTIVE IGNITION PROBLEMS ON THE VEHICLE: USING TOOLS, EQUIPMENT, AND SPECIFICATIONS CALLED FOR IN THE JOB. |
| TOOLS AND EQUIPMENT: | FENDER COVERS, SEAT COVER, DROPLIGHT, TIMING LIGHT, TACH AND DWELL METER, VOLTMETER, AMMETER, HAND TOOLS, AUXILIARY STARTER SWITCH |
| MATERIALS: | HEAT RESISTANT LUBRICANT, CLEAN RAGS |
| TEACHING AIDS: | JOB AND TASK SHEETS VIII-A-1 |
| REFERENCES: | INFORMATION SHEET VIII-A-1(IS) "ISOLATING IGNITION PROBLEMS ON THE VEHICLE" |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS. THE STUDENT MUST HAVE SATISFACTORILY PERFORMED THE PRECEDING TASKS IN MINOR BLOCK VIII-A |
| CHECKING STANDARDS: | 1. TOOL AND EQUIPMENT SELECTION<br>2. TEST HOOKUPS<br>3. VEHICLE PREPARATION<br>4. SAFE WORKING HABITS<br>5. CRAFTSMANLIKE PERFORMANCE OF TASKS<br>6. ATTITUDE OF APPRECIATION FOR TOOLS, EQUIPMENT, SUPPLIES, AND CUSTOMER'S VEHICLE<br>7. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR<br>8. DIAGNOSIS OF IGNITION PROBLEMS |

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## I. PREPARATION (OF THE LEARNER-MOTIVATION)

WHEN PERFORMING TESTS, ADJUSTMENTS, OR REPAIRS ON AUTOMOBILE IGNITION SYSTEMS IT IS ESSENTIAL TO FOLLOW THE PROCEDURES AND SPECIFICATIONS OF THE MANUFACTURER. TOO, IT IS NECESSARY TO REFER TO THE TEST EQUIPMENT MANUFACTURER'S HANDBOOK FOR HOOKUPS FOR SPECIFIC TESTS.

IGNITION PROBLEMS ARE CAUSED BY A BREAKDOWN IN THE PRIMARY, SECONDARY, OR PERHAPS BOTH CIRCUITS. MECHANICAL PROBLEMS CAN BE INCORRECT TIMING OR INCORRECT DISTRIBUTOR ADVANCE.

## I. PREPARATION (CON'T)

CIRCUIT FAILURES CAN BE SHORTS, CORRODED OR DIRTY TERMINALS, LOOSE CONNECTIONS, DEFECTIVE INSULATION, CRACKED DISTRIBUTOR CAP OR ROTOR, DEFECTIVE BREAKER POINTS, FOULED SPARK PLUGS, OR IMPROPER ANGLE OF DWELL.

THIS LESSON WILL PRESENT THE SPARK INTENSITY TESTING PROCEDURE FOR LOCATING IGNITION SYSTEM PROBLEMS.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION AND PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 2. ISOLATE PROBLEM CIRCUIT | 1. CONNECT AUXILIARY STARTER SWITCH INTO STARTING CIRCUIT |
| | 2. REMOVE COIL SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP<br>NOTE: THIS TEST IS NOT TO BE PERFORMED ON VEHICLES EQUIPPED WITH ELECTRONIC IGNITION |
| | 3. USE HIGH TENSION IGNITION PLIERS ON COIL SECONDARY WIRE |
| | 4. HOLD END OF COIL SECONDARY WIRE APPROXIMATELY 3/16 INCH FROM CYLINDER HEAD OR ANY GOOD GROUND |
| | 5. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH |
| | 6. IF THE SPARK IS GOOD AND STRONG THE TROUBLE IS IN THE PRIMARY CIRCUIT |
| | 7. IF THERE IS NO SPARK OR A WEAK SPARK, TROUBLE IS IN THE SECONDARY CIRCUIT, COIL TO DISTRIBUTOR HIGH TENSION LEAD, OR THE COIL |
| 3. PRIMARY CIRCUIT TEST | |
| A. BATTERY TO COIL VOLTMETER TEST | 1. REMOVE THE PRIMARY LEAD FROM THE COIL, SWITCH SIDE |
| | 2. POSITION A BARE METAL EXTENSION BETWEEN COIL PRIMARY TERMINAL AND PRIMARY LEAD TERMINAL |

3. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION ON COIL PRIMARY TERMINAL
4. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
5. REMOVE PRIMARY LEAD FROM COIL, DISTRIBUTOR SIDE
6. INSTALL JUMPER ON PRIMARY TERMINAL, DISTRIBUTOR SIDE
7. GROUND OPPOSITE END OF JUMPER ON DISTRIBUTOR HOUSING
8. TURN OFF ALL LIGHTS AND ACCESSORIES
9. TURN THE IGNITION SWITCH TO ON POSITION
10. OBSERVE VOLTMETER READING
11. IF READING ON VOLTMETER IS BETWEEN 4.5 AND 6.9 VOLTS, PRIMARY CIRCUIT FROM BATTERY TO COIL IS SATISFACTORY
12. IF READING ON VOLTMETER IS MORE THAN 6.9 VOLTS, CHECK:
    a. BATTERY POSTS AND CABLES FOR CORROSION OR LOOSE CONNECTIONS
    b. PRIMARY WIRING
        (1) DAMAGED OR WORN INSULATION
        (2) BROKEN STRANDS OF WIRE
        (3) LOOSE OR CORRODED CONNECTIONS
13. IF THE READING ON VOLTMETER IS LESS THAN 4.5 VOLTS:
    a. REPLACE IGNITION RESISTANCE WIRE
    b. CHECK STARTER RELAY TO IGNITION SWITCH FOR DAMAGE

B. STARTING IGNITION CIRCUIT VOLTMETER TEST

1. INSTALL AUXILIARY STARTER SWITCH IN STARTING CIRCUIT
2. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE
3. CONNECT A BARE METAL EXTENSION BETWEEN COIL PRIMARY SWITCH TERMINAL AND SWITCH LEAD

4. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION AT COIL SWITCH, PRIMARY SIDE
5. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
6. REMOVE COIL TO DISTRIBUTOR SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP
7. GROUND THE SECONDARY WIRE JUST REMOVED FROM DISTRIBUTOR
8. TURN IGNITION SWITCH TO OFF POSITION
9. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH
10. OBSERVE VOLTMETER FOR VOLTAGE DROP
11. IF VOLTAGE DROP IS 0.4 VOLT OR LESS, STARTING IGNITION CIRCUIT IS SATISFACTORY
12. IF VOLTAGE DROP IS GREATER THAN 0.4 VOLT:
    a. CLEAN AND TIGHTEN TERMINALS IN CIRCUIT
    b. OR REPLACE WIRING AS NEEDED

### C. IGNITION SWITCH VOLTMETER TEST

1. CHECK VEHICLE WIRING DIAGRAM, LOCATE DISCONNECT FOR IGNITION SWITCH LEAD
2. SEPARATE WIRING HARNESS SWITCH LEAD FROM IGNITION SWITCH
3. FABRICATE JUMPER LEAD
    a. USE WIRE SIMILAR TO IGNITION SWITCH
    b. DETERMINE LENGTH OF WIRE NEEDED
    c. PEEL OFF $\frac{1}{2}$ INCH OF INSULATION IN CENTER OF WIRE
    d. REMOVE $\frac{1}{4}$ INCH OF INSULATION FROM EACH END OF WIRE
    e. INSTALL A FEMALE CONNECTOR ON ONE END OF WIRE
    f. INSTALL A MALE CONNECTOR ON OPPOSITE END OF WIRE

4. CONNECT JUMPER LEAD BETWEEN IGNITION SWITCH AND SWITCH PRIMARY LEAD IN WIRING HARNESS
5. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE MIDDLE SECTION OF JUMPER LEAD
6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
7. INSTALL JUMPER WIRE BETWEEN DISTRIBUTOR PRIMARY TERMINAL ON COIL AND A GOOD GROUND ON THE DISTRIBUTOR BODY
8. TURN OFF ALL ACCESSORIES AND LIGHTS
9. TURN THE IGNITION SWITCH TO ON POSITION
10. IF VOLTMETER READING IS 0.3 VOLT OR LESS, IGNITION SWITCH AND RELAY TO SWITCH WIRE ARE SATISFACTORY
11. IF VOLTMETER READING IS GREATER THAN 0.3 VOLT:
    a. IGNITION SWITCH IS DAMAGED
    b. RELAY TO SWITCH WIRE IS DAMAGED

D. RESISTANCE WIRE VOLTAGE TEST

1. CHECK VEHICLE WIRING DIAGRAM, LOCATE DISCONNECT FOR IGNITION SWITCH LEAD
2. SEPARATE WIRING HARNESS SWITCH LEAD FROM SWITCH
3. FABRICATE JUMPER LEAD
    a. USE WIRE SIMILAR TO IGNITION SWITCH LEAD
    b. DETERMINE LENGTH OF WIRE NEEDED
    c. REMOVE ¼ INCH OF INSULATION FROM EACH END OF WIRE
    d. INSTALL FEMALE CONNECTOR ON ONE END OF JUMPER
    e. INSTALL MALE CONNECTOR ON SECOND END OF JUMPER
4. INSTALL END OF JUMPER LEAD ON IGNITION SWITCH LEAD

5. CONNECT POSITIVE LEAD OF VOLTMETER TO SECOND END OF JUMPER
6. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE
7. INSTALL BARE METAL EXTENSION BETWEEN PRIMARY COIL SWITCH LEAD AND COIL TERMINAL
8. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION
9. GROUND PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE
10. TURN OFF ALL ACCESSORIES AND LIGHTS
11. TURN THE IGNITION SWITCH TO ON POSITION
12. OBSERVE VOLTMETER READING
13. IF VOLTMETER READING IS BETWEEN 6.6 AND 4.5 VOLTS, RESISTANCE WIRE IS SATISFACTORY
14. IF VOLTMETER READING IS GREATER THAN 6.6 VOLTS OR LESS THAN 4.5 VOLTS, REPLACE RESISTANCE WIRE
15. REMOVE TEST EQUIPMENT, MAKE ALL NECESSARY CONNECTIONS

E. COIL TO GROUND VOLTMETER TEST

1. REMOVE COIL PRIMARY LEAD, DISTRIBUTOR SIDE
2. CONNECT BARE METAL EXTENSION BETWEEN COIL PRIMARY LEAD AND COIL TERMINAL
3. CONNECT PRIMARY LEAD OF VOLTMETER TO METAL EXTENSION
4. GROUND VOLTMETER NEGATIVE LEAD
5. REMOVE DISTRIBUTOR CAP
6. TURN ENGINE OVER
7. CLOSE BREAKER POINT CONTACTS
8. INSTALL DISTRIBUTOR CAP ON THE DISTRIBUTOR
9. TURN OFF ACCESSORIES AND LIGHTS
10. TURN THE IGNITION SWITCH TO ON POSITION
11. OBSERVE VOLTMETER READING
12. IF VOLTMETER READING IS 0.25 VOLT OR LESS, PRIMARY CIRCUIT FROM COIL TO GROUND IS SATISFACTORY

13. IF VOLTMETER READING IS GREATER THAN 0.25 VOLT, TEST VOLTAGE DROP BETWEEN EACH OF THE FOLLOWING:
    a. COIL AND BREAKER POINT PRIMARY LEAD CONNECTIONS
    b. MOVABLE BREAKER POINT
    c. BREAKER PLATE

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PRACTICE ON TASKS UNDER CLOSE SUPERVISION.
2. USE JOB AND TASK SHEETS.
3. RETEACH IF THE NEED ARISES.
4. USE CHECKING STANDARDS AS OUTLINED IN HEADING OF LESSON TO CHECK STUDENT'S PERFORMANCE.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON THEIR OWN.
2. USE PERFORMANCE TEST.
3. RECORD SATISFACTORY STUDENT PERFORMANCE IN PROGRESS CHART.
4. IF PERFORMANCE IS NOT SATISFACTORY, RETEACH.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY WHEN DEALING WITH ELECTRICITY.
2. POINT OUT FUNCTION, DIFFERENCE, AND TEST FOR PRIMARY AND SECONDARY CIRCUITS.
3. EMPHASIZE NEED AND NECESSITY FOR MAKING CORRECT TEST HOOKUPS.
4. EMPHASIZE NEED FOR CORRECT TEST RESULTS AND SERVICE NECESSARY TO CORRECT PROBLEMS

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 292-294
AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436

THE NEXT LESSON IS: VIII-A-2(S), "TEST AND SERVICE ELECTRONIC IGNITION SYSTEM" (CHRYSLER)

VIII-A-1(J)

# JOB SHEET
# IN
# IGNITION SYSTEM

JOB: ISOLATE IGNITION PROBLEMS ON THE VEHICLE

MATERIALS: CLEAN RAGS, HEAT RESISTANT LUBRICANT

TOOLS AND EQUIPMENT: FENDER COVERS, SEAT COVER, DROPLIGHT, TACH AND DWELL METER, VOLTMETER, HAND TOOLS, AUXILIARY STARTER SWITCH

GENERAL INSTRUCTIONS: BEFORE STARTING THE JOB READ REFERENCES AND STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE STARTING ENGINE AND AFTER MAKING TEST HOOKUPS PRIOR TO PERFORMING TASKS.

PROCEDURES AND/OR TASKS:

| | |
|---|---|
| VIII-A-1(TS) | ISOLATE PROBLEM CIRCUIT |
| VIII-A-1a(TS) | MAKE BATTERY TO COIL TEST |
| VIII-A-1b(TS) | TEST STARTING IGNITION CIRCUIT |
| VIII-A-1c(TS) | TEST IGNITION SWITCH AND RESISTANCE WIRE |
| VIII-A-1d(TS) | PERFORM COIL TO GROUND TEST |
| | CLEAN WORK STATION AS IN PRECEDING TASKS |

## TASK SHEET VIII-A-1(TS)

**TASK:** ISOLATE PROBLEM CIRCUIT

**JOB:** ISOLATE IGNITION PROBLEMS ON VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, HAND TOOLS, DROPLIGHT, AUXILIARY STARTER SWITCH, HIGH TENSION IGNITION PLIERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. CONNECT AUXILIARY STARTER INTO STARTING CIRCUIT<br>2. REMOVE COIL SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP<br>NOTE: THIS TEST IS NOT TO BE PERFORMED ON VEHICLES EQUIPPED WITH ELECTRONIC IGNITION BECAUSE OF SAFETY FACTOR<br>3. USE HIGH TENSION IGNITION PLIERS TO HOLD SECONDARY WIRE |
| 2. PERFORM TEST | 1. HOLD END OF COIL SECONDARY WIRE APPROXIMATELY 3/16 INCH FROM CYLINDER HEAD OR ANY GOOD GROUND<br>2. CRANK ENGINE OVER WITH AUXILIARY STARTER<br>3. STRONG SPARK INDICATES TROUBLE IS IN PRIMARY CIRCUIT<br>4. WEAK OR NO SPARK INDICATES TROUBLE IS IN THE SECONDARY CIRCUIT<br>a. COIL TO DISTRIBUTOR HIGH TENSION LEAD<br>b. COIL<br>5. PREPARE TO TEST MALFUNCTIONING CIRCUIT |

## TASK SHEET

VIII-A-1a(TS)

**TASK:** MAKE BATTERY TO COIL TEST

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVERS, DROPLIGHT, HAND TOOLS, METAL ELECTRICAL EXTENSION, VOLTMETER, JUMPER LEAD

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE |
| | 2. INSTALL BARE METAL EXTENSION ON PRIMARY TERMINAL ON SWITCH SIDE OF COIL |
| | 3. INSTALL SWITCH SIDE PRIMARY COIL LEAD ON METAL EXTENSION |
| | 4. CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION ON COIL |
| | 5. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF THE BATTERY |
| | 6. REMOVE PRIMARY LEAD FROM DISTRIBUTOR SIDE OF COIL |
| | 7. INSTALL JUMPER WIRE ON PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE |
| | 8. GROUND OPPOSITE END OF JUMPER LEAD ON DISTRIBUTOR HOUSING |
| | 9. TURN OFF ALL LIGHTS AND ACCESSORIES |
| 2. PERFORM TEST | 1. TURN THE IGNITION SWITCH TO ON POSITION |
| | 2. CHECK VOLTMETER READING |
| | 3. A READING BETWEEN 4.5 AND 6.9 VOLTS INDICATES PRIMARY CIRCUIT FROM BATTERY TO COIL IS SATISFACTORY |
| | 4. IF READING ON VOLTMETER EXCEEDS 6.9 VOLTS CHECK: |
| | a. BATTERY POST AND CABLES FOR CORROSION OR LOOSE CONNECTION |

| STEPS | KEY POINTS |
|---|---|
| | b. PRIMARY WIRING FOR<br>(1) DAMAGED OR WORN INSULATION<br>(2) BROKEN STRANDS OF WIRE<br>(3) LOOSE OR CORRODED CONNECTIONS<br>5. IF READING IS LESS THAN 4.5 VOLTS:<br>a. REPLACE IGNITION RESISTANCE WIRE<br>b. CHECK STARTER RELAY TO IGNITION SWITCH FOR DAMAGE<br>6. DISCONNECT ALL TEST CONNECTIONS<br>7. MAKE ALL NORMAL HOOKUPS |

## TASK SHEET

VIII-A-1b(TS)

**TASK:** TEST STARTING IGNITION CIRCUIT

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, DROPLIGHT, VOLTMETER, AUXILIARY STARTER SWITCH, METAL EXTENSION

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. INSTALL AUXILIARY STARTER SWITCH INTO STARTING CIRCUIT |
| | 2. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE |
| | 3. INSTALL BARE METAL EXTENSION ON SWITCH SIDE OF COIL, PRIMARY TERMINAL |
| | 4. CONNECT COIL SWITCH SIDE PRIMARY LEAD TO BARE METAL EXTENSION ON COIL |
| | 5. CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION ON COIL |
| | 6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF BATTERY |
| | 7. REMOVE COIL TO DISTRIBUTOR SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP |
| | 8. GROUND SECONDARY COIL WIRE |
| | 9. THE IGNITION SWITCH IS TO BE IN OFF POSITION |
| 2. PERFORM TEST | 1. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH |
| | 2. OBSERVE VOLTMETER, CHECK FOR VOLTAGE DROP |
| | 3. A VOLTAGE DROP OF 0.4 VOLT OR LESS INDICATES THAT THE STARTING IGNITION CIRCUIT IS SATISFACTORY |
| | 4. IF VOLTAGE DROP IS GREATER THAN 0.4 VOLT:<br>a. CLEAN AND TIGHTEN ALL TERMINALS IN THE CIRCUIT |

| STEPS | KEY POINTS |
|---|---|
| | b. OR REPLACE WIRING AS NEEDED |
| | 5. DISCONNECT TEST HOOKUP |
| | 6. MAKE ALL NORMAL HOOKUPS |

## TASK SHEET

VIII-A-1c(TS)

**TASK:** TEST IGNITION SWITCH AND RESISTANCE WIRE

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, DROPLIGHT, VEHICLE WIRING DIAGRAM, JUMPER LEAD, VOLTMETER, METAL EXTENSION, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. FABRICATE JUMPER LEAD | 1. USE WIRE VERY SIMILAR TO OR SAME TYPE AS IGNITION PRIMARY WIRE<br>2. DETERMINE LENGTH OF WIRE NEEDED<br>3. PEEL $\frac{1}{4}$ INCH OF INSULATION FROM CENTER SECTION OF WIRE<br>4. PEEL $\frac{1}{2}$ INCH OF INSULATION FROM CENTER SECTION OF WIRE<br>5. SELECT MALE AND FEMALE WIRE TERMINALS COMPARABLE TO TERMINALS ON VEHICLE SWITCH WIRE AND SWITCH<br>6. INSTALL TERMINALS ON ENDS OF THE JUMPER WIRE, MAKE SURE TERMINALS ARE FIRMLY ATTACHED TO WIRE FOR GOOD ELECTRICAL CONTACT |
| 2. MAKE TEST HOOKUP FOR IGNITION SWITCH | 1. CHECK VEHICLE WIRING DIAGRAM, LOCATE DISCONNECT FOR IGNITION SWITCH LEAD<br>2. SEPARATE WIRING HARNESS SWITCH LEAD FROM IGNITION SWITCH<br>3. CONNECT FABRICATED JUMPER LEAD TO IGNITION SWITCH TERMINAL<br>4. CONNECT SECOND END OF JUMPER LEAD TO SWITCH PRIMARY LEAD IN WIRING HRNESS<br>5. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE MIDDLE SECTION OF JUMPER LEAD<br>6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF BATTERY |

| STEPS | | KEY POINTS |
|---|---|---|
| | 7. | DISCONNECT DISTRIBUTOR PRIMARY LEAD FROM COIL |
| | 8. | CONNECT A JUMPER LEAD TO DISTRIBUTOR PRIMARY TERMINAL ON COIL |
| | 9. | GROUND OPPOSITE END OF JUMPER TO A GOOD GROUND ON DISTRIBUTOR HOUSING |
| | 10. | TURN OFF ALL ACCESSORIES AND LIGHTS |
| 3. TEST IGNITION SWITCH | 1. | TURN IGNITION SWITCH TO ON POSITION |
| | 2. | OBSERVE VOLTMETER READING |
| | 3. | READING OF 0.3 VOLT OR LESS, IGNITION SWITCH AND RELAY TO SWITCH WIRE ARE SATISFACTORY |
| | 4. | IF VOLTMETER READING IS GREATER THAN 0.3 VOLTS:<br>a. IGNITION SWITCH IS DAMAGED<br>b. RELAY TO SWITCH WIRE IS DAMAGED<br>c. SWITCH AND WIRE ARE BOTH DAMAGED |
| | 5. | REMOVE TEST HOOKUP |
| | 6. | TURN OFF IGNITION SWITCH |
| 4. MAKE TEST HOOKUP FOR RESISTANCE WIRE | 1. | USE FABRICATED JUMPER LEAD TAPE BARE CENTER SECTION FOR INSULATION |
| | 2. | INSERT JUMPER LEAD INTO IGNITION SWITCH LEAD |
| | 3. | CONNECT POSITIVE LEAD OF VOLTMETER TO OPPOSITE END OF JUMPER |
| | 4. | REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE |
| | 5. | CONNECT BARE METAL EXTENSION TO SWITCH SIDE OF COIL |
| | 6. | CONNECT PRIMARY SWITCH LEAD TO BARE METAL EXTENSION ON COIL |
| | 7. | CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION |
| | 8. | GROUND PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE |
| | 9. | TURN OFF ALL ACCESSORIES AND LIGHTS |

| STEPS | KEY POINTS |
|---|---|
| 5. TEST RESISTANCE WIRE | 1. TURN IGNITION SWITCH TO ON POSITION<br>2. OBSERVE VOLTMETER READING<br>3. READING BETWEEN 6.6 AND 4.5 VOLTS INDICATES WIRE IS SATISFACTORY<br>4. IF VOLTAGE READING IS GREATER THAN 6.6 VOLTS OR LESS THAN 4.5 VOLTS, REPLACE RESISTANCE WIRE<br>5. REMOVE TEST EQUIPMENT<br>6. MAKE ALL NECESSARY NORMAL CONNECTIONS |

TASK SHEET VIII-A-1d(TS)

**TASK:** PERFORM COIL TO GROUND TEST

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROPLIGHT, METAL EXTENSION, VOLTMETER, HAND TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. REMOVE PRIMARY LEAD FROM COIL, DISTRIBUTOR SIDE<br>2. CONNECT BARE METAL EXTENSION TO COIL TERMINAL, DISTRIBUTOR SIDE<br>3. CONNECT PRIMARY DISTRIBUTOR LEAD TO METAL EXTENSION<br>4. CONNECT PRIMARY LEAD OF VOLTMETER TO METAL EXTENSION<br>5. GROUND NEGATIVE LEAD OF VOLTMETER<br>6. REMOVE DISTRIBUTOR CAP<br>7. TURN ENGINE OVER AND CLOSE THE BREAKER POINT CONTACTS<br>8. INSTALL DISTRIBUTOR CAP<br>9. TURN OFF ALL ACCESSORIES AND LIGHTS |
| 2. PERFORM TEST | 1. TURN IGNITION SWITCH TO ON POSITION<br>2. OBSERVE VOLTMETER READING<br>3. A READING OF 0.25 VOLT OR LESS INDICATES PRIMARY CIRCUIT FROM COIL TO GROUND IS SATISFACTORY<br>4. IF VOLTMETER READING IS GREATER THAN 0.25 VOLTS, TEST VOLTAGE DROP BETWEEN EACH OF THE FOLLOWING:<br>a. COIL AND BREAKER POINT TERMINAL LEAD CONNECTIONS<br>b. MOVABLE BREAKER POINT<br>c. BREAKER PLATE |

| STEPS | KEY POINTS |
|---|---|
| 3. CLEAN WORK STATION | AS IN PRECEDING TASKS |

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INFORMATION SHEET CHRYSLER VIII-A-2 (IS)

## INFORMATION SHEET
## ON
## ELECTRONIC IGNITION SYSTEM

SUBJECT: Electronic Ignition System

### INTRODUCTORY INFORMATION:

The breaker-point ignition has been steadily improved and is an excellent system. However, regular periodic service is required to maintain satisfactory ignition performance. Of all the breaker-point ignition components, the breaker-points have the shortest service life. Of course, spark plugs eventually wear out, but the coil, condenser, and ballast resistor have been improved to the point that they should virtually last the life of the car.

In an engine equipped with breaker-point ignition, there is a slight but continuous change in ignition timing over the life of the points. This is because the contact gap closes and timing starts to retard as a result of rubbing-block wear. As the contact gap closes, the dwell in a breaker-point system is also affected.

Engine performance can be maintained as the points wear by resetting the timing or adjusting the contact gap if the dwell is noticeably off. However, even when the breaker-points are kept properly adjusted, they will deteriorate in normal usage due to metal transfer caused by arcing across the points, oxidation, and erosion. Eventually, this will cause misfiring.

When the contacts deteriorate to the point where they cause misfiring, they should be replaced. When an engine begins to misfire, it also causes spark plug deterioration and shortens plug life considerably. Unfortunately, the average owner does not have tune up performed often enough to prevent or, for that matter, to correct misfiring.

With the electronic ignition system, periodic distributor service will be a thing of the past since the breaker-points have been replaced by electronic components and circuitry.

### GENERAL INFORMATION

The distributor housing, the advance mechanism, the rotor, and the distributor cap are the same for the electronic ignition and the conventional breaker-point ignition. Both systems use the same type ignition coil and spark plugs. A dual ballast resistor is used. With the exception of the drive and advance mechanisms the components inside the electronic distributor are new. The pick-up unit and reluctor have physically replaced the cam and breaker-points.

The pick-up and reluctor do the same basic job that the cam and breaker-points do but they do it quite differently. A condenser is no longer required.

The pick-up unit consists of a permanent magnet and a coil that is wound around a pole piece. The pole piece is an extension of the mounting bracket and is attached to the permanent magnet. Because of the arrangement, the pick-up unit resembles a horseshoe type magnet with the reluctor end of the pole piece acting as one of the poles.

The reluctor is a gear like component that is attached to the distributor shaft in the same position as the cam in a breaker-point ignition. The reluctor is not a magnet but it does provide a better magnetic path than air. In other words, it is capable of reducing reluctance (resistance to magnetic flow) and this is the reason for calling it a reluctor.

In a very general way, the reluctor and the pick-up unit do electrically what the cam and rubbing block do mechanically in a breaker-point ignition. Although the electronic distributor components replace the cam and breaker-points, they operate quite differently. For one thing, the pick-up unit is not a set of points, and there must be no contact between the reluctor and the pick-up unit.

A short review of the breaker-point system will help to understand how the reluctor and pick-up unit work. In a breaker-point system, the current flowing through the primary winding of the ignition coil is interrupted when the breaker-points are opened by the rotating cam. The collapsing magnetic field in the ignition coil primary induces enough voltage in the ignition coil secondary to fire the plugs.

In the electronic ignition system a permanent magnet in the pick-up unit provides a magnetic field from the pole piece to the permanent magnet itself. This magnetic field passes through the coil that is wound around the pole piece. The magnetic field is relatively weak because the air gap between the pole piece and the magnet does not provide a good magnetic path between the two.

As a tooth of the reluctor approaches the pick-up, it provides a better path than the air gap and the strength of the magnetic field in the pick-up is increased. Increasing the field strength at the pick-up coil induces a positive voltage at one terminal of the coil. It should be understood that this voltage is induced as a result of the changing (increasing) field strength and is not caused by physical movement of the field or the pick-up coil. The positive voltage continues to build until the reluctor tooth is exactly opposite the pole piece.

As soon as the reluctor tooth passes the pole piece, the air gap starts to increase and the field strength begins to decrease. The decreasing field strength through the coil winding induces a negative voltage at the same terminal of the coil winding. Again, the voltage is induced by the change (reduction) in field strength. No voltage is induced in the pick-up coil unless the reluctor is moving. The rapid increase and decrease of the magnetic field as the rotating reluctor teeth approach and pass the pole piece is what induces the positive then the negative voltage.

The induced voltage is very small. It is just a tiny electrical signal that is fed into the electronic control unit. The function of the signal voltage induced in the pick-up unit is not the same as that of the contacts in a breaker-point ignition which open and interrupt the primary current in the ignition coil. The pick-up voltage is a precisely timed signal. It triggers the electronic circuitry in the control unit, and in turn this controls the interruption of the current flowing through the primary windings of the ignition coil.

In the electronic ignition system, battery current flows through the primary winding of the ignition coil and then through the control unit which is grounded. This maintains current flow in the ignition coil primary winding pretty much the same as the closed contacts do in a breaker-point ignition. The control unit remains "on" or activated and current flows through the primary coil windings as long as a negative voltage from the pick-up is not applied to it.

When the reluctor passes the pole piece, and the pick-up voltage turns negative, it deactivates or "turns off" the control unit circuitry. At this point, current cannot flow through the control unit to ground, and therefore the current through the ignition coil primary windings is interrupted. Like in all induction coil-ignition systems, this interruption of the current flow in the primary circuit induces enough voltage in the secondary winding of the ignition coil to fire the spark plug.

The control unit determines electronically how long the ignition coil primary current is allowed to flow before it is interrupted. In other words, it determines the dwell in the electronic system. Since the control unit circuitry is sealed and has no moving parts, the dwell cannot be changed. The reluctor and the pick-up unit determine ignition timing. The control unit determines dwell. However, it takes both of them working together to time the interruption of the ignition coil primary current and the firing of the plugs.

There is no reason to use a dwell meter when testing or checking an electronic ignition system. Dwell will be correct unless the control unit has been damaged, and this possibility can be easily and quickly checked out with an electronic ignition tester. On the other hand, the usual tachometer and timing light will operate just as well with this system as they will with a breaker-point system.

The ballast resistor for the electronic system plays a dual role. On the one side is the half-ohm ballast resistor that is the same as in a breaker-point system. It maintains constant primary current with variations in engine speed. This protects the ignition coil against high current flow at low engine speed. This ballast resistor is bypassed when cranking, to apply full battery voltage to the coil.

The other side of the dual unit is a five-ohm resistor. It protects the control unit by limiting current flow in the electronic part of the circuit. In a breaker-point ignition, the condenser helps the coil develop higher voltage because it speeds up the collapse of the magnetic field. It also increases ignition point life because it reduces arcing as the contacts open. The condenser is not needed in the electronic ignition because there are no points and the collapse of the field in the ignition coil primary is controlled by the electronic circuitry in the control unit.

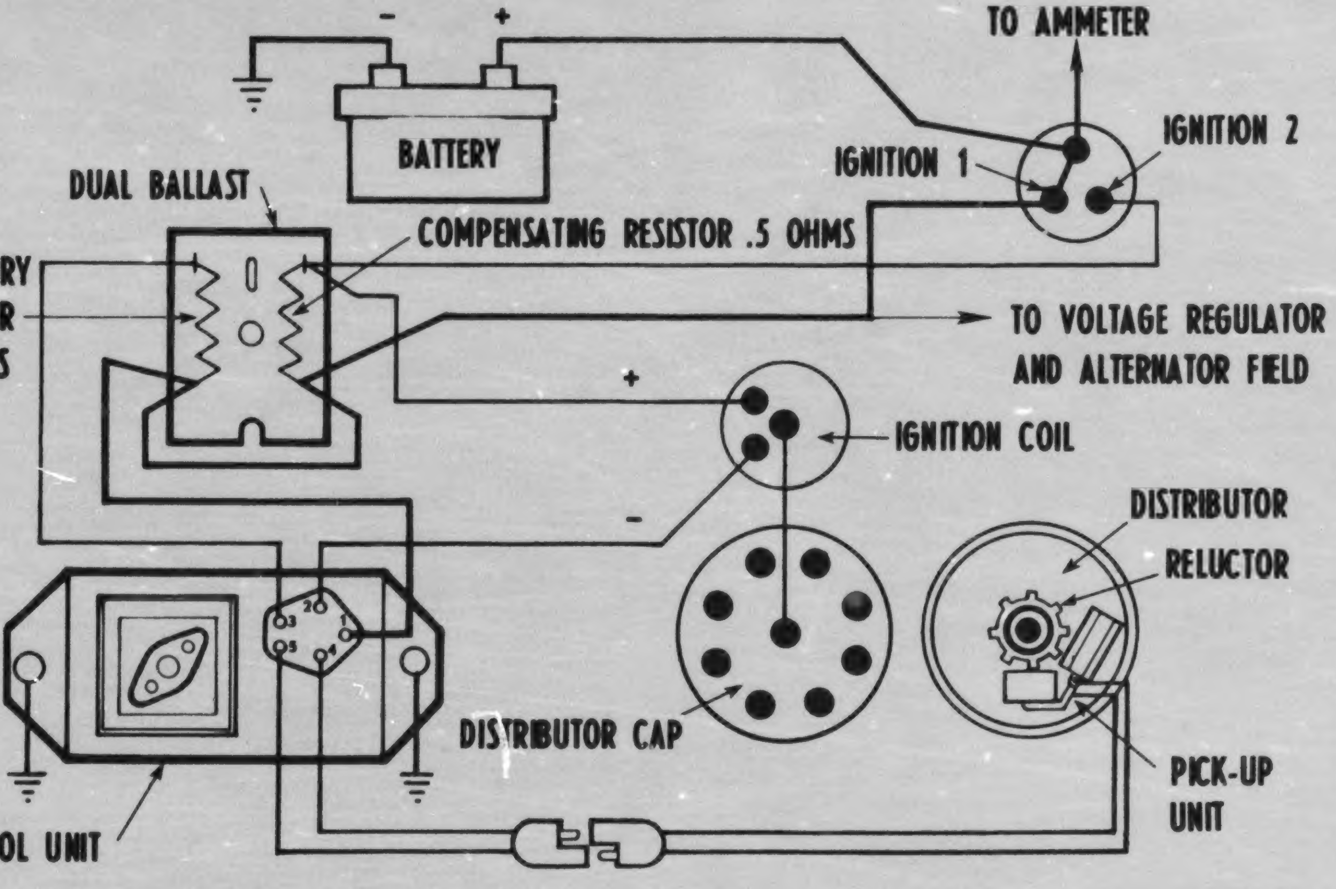
Learn to use the tester available in the shop. Study the instructions which are included with the tester.

If performance problems exist, the first thing to check on the ignition system are the rotor and distributor cap for cracks or corroded terminals. Hairline cracks are sometimes difficult to see; therefore, look the cap and rotor over very carefully.

Visually inspect the secondary ignition cables and check their performance with an ohmmeter or an ignition oscilloscope. Then check the spark plugs and regap or replace them if necessary.

Check the control unit. With the ignition switch off, remove the screw and disconnect the wiring harness from the control unit. Connect tester between the control unit and the wiring harness. This is to put the tester in the ignition system circuit. Turn the ignition switch to the "on" position; engine is not to be started. Take readings from tester indicator.

# CHRYSLER ELECTRONIC IGNITION SYSTEM


-
+
BATTERY
TO AMMETER
IGNITION 2
IGNITION 1
DUAL BALLAST
COMPENSATING RESISTOR .5 OHMS
AUXILIARY RESISTOR 5 OHMS
TO VOLTAGE REGULATOR AND ALTERNATOR FIELD
+
IGNITION COIL
-
DISTRIBUTOR
RELUCTOR
1
2
3
4
5
DISTRIBUTOR CAP
PICK-UP UNIT
CONTROL UNIT

VIII-A-2(IS)

VIII-A-2(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | TEST AND SERVICE ELECTRONIC IGNITION SYSTEM (CHRYSLER) |
| AIM: | 1. THE STUDENT WILL BE ABLE TO DIAGNOSE, DETERMINE MALFUNCTIONS OF AN ELECTRONIC IGNITION SYSTEM, AND PIN POINT TROUBLE AREAS; USING THE RECOMMENDED PROCEDURES, TEST EQUIPMENT, AND TOOLS<br>2. THE STUDENT WILL BE ABLE TO REPAIR AND SERVICE AN ELECTRONIC IGNITION SYSTEM PUTTING IT BACK INTO OPERATION ACCORDING TO SPECIFICATIONS; USING THE PROPER PROCEDURES, PARTS, TOOLS, AND EQUIPMENT |
| TOOLS AND EQUIPMENT: | FENDER COVERS, SEAT COVERS, DROPLIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | JOB AND TASK SHEETS, VIII-A-2(J) |
| REFERENCES: | AUTOMECHANICS, PP. 292-294<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436<br>INFORMATION SHEET, VIII-A-2(IS) |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENTS MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS. STUDENTS MUST HAVE SATISFACTORILY COMPLETED JOBS ON THE BREAKER POINT SYSTEM. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. JOB PREPARATION<br>3. TEST PROCEDURES AND SETUP<br>4. FOLLOW SPECIFICATIONS AND PROCEDURES<br>5. HOLD ALL ADJUSTMENTS TO SPECIFICATIONS<br>6. MAINTAIN TOOLS AND EQUIPMENT IN GOOD WORKING CONDITION<br>7. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE<br>8. MAINTAIN CRAFTSMANLIKE STANDARDS OF WORK<br>9. MAINTAIN SAFE WORKING HABITS |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE DISTRIBUTOR HOUSING, ADVANCE MECHANISM, ROTOR, AND CAP ARE THE SAME FOR THE ELECTRONIC IGNITION SYSTEM AS THE BREAKER POINT SYSTEM.

THE COIL AND SPARK PLUGS HAVE NOT BEEN CHANGED. THEREFORE, SERVICE PROCEDURES FOR THESE TWO PARTS ARE THE SAME. INFORMATION FOR THESE PARTS WILL NOT BE REPEATED IN THIS LESSON.

INSIDE THE DISTRIBUTOR THE DRIVE AND ADVANCE MECHANISMS HAVE NOT BEEN CHANGED.

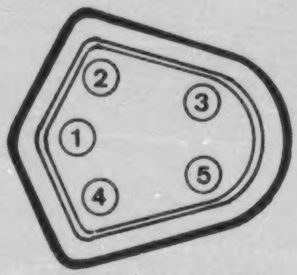
NO LONGER ARE BREAKER POINTS USED; THEY HAVE BEEN REPLACED BY ELECTRONIC COMPONENTS AND CIRCUITRY.

WHEN WORKING WITH THE ELECTRONIC IGNITION SYSTEM IT IS IMPERATIVE THAT ALL SAFETY MEASURES BE OBSERVED. RESPECT THE ELECTRICITY THAT FLOWS THROUGH THIS SYSTEM.

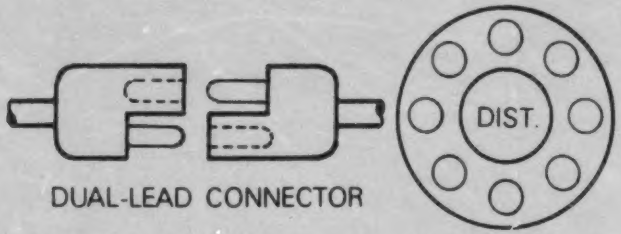
MAKE SURE THAT VOLTMETER AND OHMMETER ARE CORRECTLY CALIBRATED BEFORE MAKING TESTS.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. INSPECT BATTERY | AS IN PRECEDING TASKS |
| 4. CHECK PRIMARY WIRES | 1. AT IGNITION COIL<br>a. GOOD CONDITION<br>b. TIGHT AT TERMINALS<br>2. AT BALLAST RESISTOR<br>a. GOOD CONDITION<br>b. TIGHT AT TERMINALS |
| 5. ADJUST AIR GAP | 1. BETWEEN THE RELUCTOR TOOTH AND PICK-UP COIL TOOTH<br>2. REMOVE DISTRIBUTOR CAP<br>3. ROTATE DISTRIBUTOR SHAFT UNTIL ONE RELUCTOR TOOTH IS DIRECTLY OPPOSITE PICK-UP COIL TOOTH<br>4. LOOSEN PICK-UP COIL HOLD DOWN SCREW |

| | |
|---|---|
| | 5. SELECT .008" NON-FERROUS FEELER GAUGE<br>6. INSERT GAUGE BETWEEN RELUCTOR TOOTH AND PICK-UP COIL TOOTH<br>7. ADJUST PICK-UP COIL SO THAT .008" FEELER GAUGE IS SNUG<br>8. TIGHTEN PICK-UP COIL HOLD DOWN SCREW<br>9. RECHECK AIR GAP<br>10. REPLACE DISTRIBUTOR CAP |
| 6. CHECK SECONDARY CIRCUIT | SAME AS CONVENTIONAL IGNITION SYSTEM |
| 7. PREPARE FOR IGNITION SYSTEM CHECK | 1. TURN OFF IGNITION SWITCH<br>2. DISCONNECT BATTERY<br>NOTE: SAFETY PRECAUTION AGAINST DAMAGE TO SYSTEM FOR METER HOOK-UP<br>3. REMOVE THE MULTI-WIRE CONNECTOR FROM CONTROL UNIT<br>4. TURN CONNECTOR OVER TO EXPOSE CAVITIES<br>5. CHECK CONNECTOR CAVITIES FOR NUMBERS<br> <br>MULTI-WIRE CONNECTION<br>MULTI-WIRE CONNECTION |
| 8. TEST PICK-UP COIL | 1. CONNECT OHMMETER TO MULTI-WIRE CONNECTOR CAVITIES 4 AND 5<br>2. CHECK OHMMETER READING<br>NOTE: OHMMETER SHOULD INDICATE BETWEEN 350 AND 550 OHMS. IF READING IS HIGHER OR LOWER THAN SPECIFICATIONS |

3. DISCONNECT DUAL-LEAD CONNECTOR ON LEAD FROM DISTRIBUTOR



4. REMOVE OHMMETER LEADS FROM CAVITIES 4 AND 5
5. CONNECT OHMMETER TO DUAL-LEAD CONNECTOR TO DISTRIBUTOR

   NOTE: RESISTANCE SHOULD READ BETWEEN 350-550 OHMS. IF READING IS NOT TO SPECIFICATIONS REPLACE PICK-UP COIL

   NOTE: IF READING IS WITHIN LIMITS PERFORM SECOND TEST

6. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND
7. LEAVE SECOND OHMMETER LEAD ATTACHED TO CONNECTOR

   NOTE: OHMMETER IS TO SHOW AN OPEN CIRCUIT. IF THE OHMMETER SHOWS A READING PICK-UP COIL MUST BE REPLACED

8. REMOVE THE OHMMETER LEADS FROM GROUND AND CONNECTOR
9. CONNECT OHMMETER LEADS TO DUAL CONNECTOR BACK TO CONTROL UNIT
10. DETERMINE CONDITION OF WIRING HARNESS

9. TEST ELECTRONIC CONTROL GROUND CIRCUIT

1. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND
2. CONNECT SECOND OHMMETER LEAD TO CONTROL UNIT CONNECTOR PIN NO. 5

NOTE: OHMMETER IS TO SHOW CONTINUITY BETWEEN GROUND AND CONNECTOR PIN

NOTE: IF THERE IS NO CONTINUITY

3. LOOSEN THE CONTROL UNIT MOUNTING BOLTS
4. SPRAY BOLTS, FIRE WALL UNDER CONTACT AREA, BACKSIDE OF MOUNTING BRACKETS WITH A GOOD CONTACT CLEANER
5. TIGHTEN BOLTS
6. RECHECK GROUND

NOTE: IF CONTINUITY IS STILL NOT EVIDENT

7. REPLACE CONTROL UNIT
8. RECHECK GROUND

NOTE: IF CONTINUITY STILL DOES NOT EXIST

9. CHECK GROUND BETWEEN FIREWALL AND ENGINE
10. CHECK GROUND BETWEEN FIREWALL AND CHASSIS

CAUTION: DURING THE TESTING OF THE ELECTRONIC CONTROL GROUND CIRCUIT MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION OR THE BATTERY IS DISCONNECTED

NOTE: USING VOLTMETER CHECK AND NOTE BATTERY VOLTAGE - MINIMUM 12 VOLTS. THEN REMOVE MULTI-WIRING CONNECTOR FROM CONTROL UNIT IN PREPARATION FOR CAVITY-BY-CAVITY CHECK TO TEST THE WIRING HARNESS AND ITS CONNECTIONS

10. TEST WIRING HARNESS

1. CAVITY BY CAVITY
2. TURN IGNITION TO ON POSITION
3. CONNECT VOLTMETER TO NEGATIVE LEAD TO GOOD GROUND
4. CONNECT VOLTMETER POSITIVE LEAD TO CAVITY NO. 1 IN WIRING HARNESS

NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE, ALL ACCESSORIES OFF. IF DIFFERENT, CHECK CIRCUIT

5. HOOK POSITIVE LEAD OF VOLTMETER TO HARNESS CONNECTOR NO. 2

NOTE: VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE WITH ALL ACCESSORIES OFF. IF DIFFERENT, CHECK THE CIRCUIT

6. CONNECT POSITIVE LEAD OF VOLTMETER TO FINAL HARNESS CONNECTOR CAVITY IN THIS TEST NO. 3

NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE. IF DIFFERENT, CHECK THE CIRCUIT

NOTE: THE WIRING HARNESS CHECK IS NOW COMPLETE. HARNESS CONNECTORS NOS. 1, 2, AND 3 ARE TESTED WITH A VOLTMETER WITH IGNITION SWITCH "ON", AND CAVITIES NOS. 4 AND 5 (WHICH CHECK OUT THE PICK-UP COIL AND CONTROL UNIT) ARE TESTED WITH AN OHMMETER WITH THE IGNITION SWITCH "OFF"

11. BALLAST RESISTOR TEST

1. HOOK UP OHMMETER AND MEASURE EACH SIDE OF THE BALLAST IN TURN
2. COMPENSATING (COIL) SIDE SHOULD READ BETWEEN .50 AND .80 OHMS
3. THE AUXILIARY (CONTROL UNIT) SIDE READING SHOULD BE BETWEEN 4.75 AND 5.75 OHMS

NOTE: IF NEITHER ONE OF THESE READINGS IS OBTAINED, REPLACE THE BALLAST

NOTE: THE COIL MAY BE TESTED IN THE SAME MANNER AS A CONVENTIONAL COIL, VIII-B-2(S)

## II. PRESENTATION (CON'T)

| | |
|---|---|
| 12. IGNITION COIL TEST | 1. PRIMARY RESISTANCE ON A CHRYSLER PRESTOLITE COIL SHOULD BE BETWEEN 1.6 AND 1.79 OHMS<br>2. ON A CHRYSLER ESSEX COIL, PRIMARY RESISTANCE SHOULD BE BETWEEN 1.41 AND 1.62 OHMS<br>3. SECONDARY RESISTANCE ON CHRYSLER PRESTOLITE COILS SHOULD BE BETWEEN 9,400 AND 11,700 OHMS<br>4. ON A CHRYSLER ESSEX, SECONDARY RESISTANCE SHOULD BE BETWEEN 8,000 AND 11,200 OHMS<br>NOTE: REPLACE IGNITION COIL IF NEITHER ONE OF THESE READINGS IS OBTAINED |
| 13. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION
2. FURNISH STUDENT WITH JOB SHEET, VIII-A-2(J) AND TASK SHEETS

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON THEIR OWN TO PERFORM TASKS
2. PERFORMANCE TESTS

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REVIEW TEST PROCEDURES FROM JOB VIII-A-2(J)
2. EMPHASIZE IMPORTANCE OF AVAILABLE BATTERY VOLTAGE
3. EMPHASIZE IMPORTANCE OF STEP BY STEP TEST PROCEDURE
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ WIRING DIAGRAMS
5. EMPHASIZE IMPORTANCE OF IGNITION "OFF" AND "ON" POSITIONS
6. EMPHASIZE IMPORTANCE OF CLEAN AND TIGHT ELECTRICAL CONNECTIONS

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 292-294

AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436
INFORMATION SHEET VIII-A-2(IS)

THE NEXT LESSON IS: VIII-A-3(S), "TEST AND SERVICE ELECTRONIC IGNITION SYSTEM" (FORD)

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VIII-A-2(J)

# JOB SHEET
# IN
# ELECTRONIC IGNITION SYSTEM

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVERS, DROPLIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCE MATERIALS. STUDY JOB AND TASK SHEETS. BE SURE FENDER COVERS ARE IN POSITION ON THE VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT IGNITION SYSTEM PROBLEMS

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-A-2(TS) | CHRYSLER<br>PREPARE FOR IGNITION SYSTEM TEST |
| VIII-A-2a(TS) | TEST PICK-UP COIL |
| VIII-A-2b(TS) | TEST ELECTRONIC CONTROL GROUND CIRCUIT |
| VIII-A-2c(TS) | TEST WIRING HARNESS |
| VIII-A-2d(TS) | BALLAST RESISTOR TEST |
| VIII-A-2e(TS) | TEST IGNITION COIL |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

| | |
|---|---|
| VIII-A-2(S) | SERVICE STORAGE BATTERY |
| VIII-A-2(S) | TEST STORAGE BATTERY |
| | CLEAN WORK STATION |

TASK SHEET CHRYSLER VIII-A-2(TS)

**TASK:** PREPARE FOR IGNITION SYSTEM TEST

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FENDER COVERS, SEATCOVER, DROPLIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, CLEANING CHEMICALS-CLEANER AND SILICONE LUBRICANT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. CHECK PRIMARY WIRES AT IGNITION COIL FOR GOOD CONDITION AND TIGHT CONNECTIONS<br>2. CHECK PRIMARY WIRES AT BALLAST RESISTOR FOR GOOD CONDITION AND TIGHT CONNECTIONS |
| 4. ADJUST AIR GAP | 1. REMOVE ALL DUST, DIRT, OIL AND GREASE FROM AREAS TO BE TESTED<br>2. REMOVE DISTRICUTOR CAP. ROTATE DISTRIBUTOR SHAFT ONE RELUCTOR TOOTH IS DIRECTLY OPPOSITE PICKUP COIL TOOTH<br>3. LOOSEN PICK-UP COIL HOLD DOWN SCREW<br>4. SELECT .008" NON-FERROUS FEELER GAUGE<br>5. INSERT FEELER GAUGE BETWEEN RELUCTOR TOOTH AND PICK-UP COIL TOOTH<br>6. ADJUST PICK-UP COIL SO THAT .008" FEELER GAUGE IS SNUG<br>7. TIGHTEN PICK-UP COIL HOLD DOWN SCREW<br>8. RECHECK AIR GAP WITH .010" FEELER GAUGE |

| STEPS | KEY POINTS |
|---|---|
| | 9. REPLACE DISTRIBUTOR CAP<br>10. TEST SECONDARY CIRCUIT, SAME CHECK AS CONVENTIONAL IGNITION SYSTEM |
| 5. PREPARE FOR IGNITION SYSTEM CHECK | 1. TURN OFF IGNITION SWITCH<br>2. DISCONNECT BATTERY GROUND CABLE<br>NOTE: SAFETY PRECAUTION AGAINST DAMAGE TO SYSTEM FOR METER HOOK UP<br>3. REMOVE MULTI-WIRE CONNECTOR FROM CONTROL UNIT<br>4. TURN CONNECTOR OVER TO EXPOSE CAVITIES<br>5. CHECK CONNECTOR CAVITIES FOR NUMBERS |

## TASK SHEET VIII-A-2a(TS)

TASK: TEST PICK-UP COIL

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS, VOLTMETER OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-2(TS) |
| 4. PICK-UP COIL TEST | 1. CONNECT OHMMETER LEAD PROBES TO CONNECTOR CAVITIES NO. 4 AND NO. 5 |
| | 2. CHECK OHMMETER READING<br>NOTE: OHMMETER SHOULD INDICATE BETWEEN 350 AND 550 OHMS. IF READING IS HIGHER OR LOWER THAN SPECICATIONS |
| | 3. DISCONNECT DUAL-LEAD CONNECTOR COMING FROM DISTRIBUTOR |
| | 4. REMOVE OHMMETER LEADS FROM CAVITIES NO. 4 AND 5 |
| | 5. CONNECT OHMMETER LEADS TO DUAL-LEAD CONNECTOR<br>NOTE: RESISTANCE SHOULD READ BETWEEN 350-550 OHMS. IF READING IS NOT TO SPECIFICATIONS, REPLACE PICK-UP COIL<br>NOTE: IF READING IS WITHIN LIMITS, PERFORM SECOND TEST |
| | 6. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND |
| | 7. LEAVE SECOND OHMMETER LEAD ATTACHED TO CONNECTOR |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: OHMMETER SHOULD SHOW AN OPEN CIRCUIT. IF THE OHMMETER SHOWS A READING, PICK-UP COIL MUST BE REPLACED |
| | 8. REMOVE OHMMETER LEADS FROM THE GROUND AND CONNECTOR |
| | 9. CONNECT OHMMETER LEADS, TO DUAL CONNECTOR, BACK TO CONTROL UNIT |
| | 10. INSPECT CONDITION OF WIRING HARNESS |

TASK SHEET CHRYSLER VIII-A-2b(TS)

**TASK:** TEST ELECTRONIC CONTROL GROUND CIRCUIT

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVERS, SEAT COVERS, CONTACT CLEANER (SPRAY CAN)

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-2a(TS) |
| 4. TEST ELECTRONIC GROUND CIRCUIT | 1. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND<br>2. CONNECT SECOND OHMMETER LEAD TO CONTROL UNIT CONNECTOR PIN NO. 5<br>NOTE: OHMMETER IS TO SHOW CONTINUITY BETWEEN GROUND AND CONNECTOR PIN<br>NOTE: IF THERE IS NO CONTINUITY<br>3. LOOSEN THE CONTROL UNIT MOUNTING BOLTS<br>4. SPRAY BOLTS, FIREWALL UNDER CONTACT AREA, BACKSIDE OF MOUNTING BRACKETS WITH A GOOD CONTACT CLEANER<br>5. TIGHTEN BOLTS<br>6. RECHECK GROUND<br>NOTE: IF CONTINUITY IS STILL NOT EVIDENT<br>7. REPLACE CONTROL UNIT<br>8. RECHECK GROUND<br>NOTE: IF CONTINUITY STILL DOES NOT EXIST<br>9. CHECK GROUND BETWEEN FIREWALL AND ENGINE |

| STEPS | KEY POINTS |
|---|---|
|  | 10. CHECK GROUND BETWEEN FIREWALL AND CHASSIS<br>CAUTION: DURING THE TESTING OF THE ELECTRONIC CONTROL GROUND CIRCUIT MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION OR THE BATTERY IS DISCONNECTED<br>NOTE: USING VOLTMETER CHECK AND NOTE BATTERY VOLTAGE - MINIMUM 12 VOLTS. THEN REMOVE MULTI-WIRING CONNECTOR FROM CONTROL UNIT IN PREPARATION FOR CAVITY-BY-CAVITY CHECK TO TEST THE WIRING HARNESS AND ITS CONNECTIONS |

TASK SHEET CHRYSLER VIII-A-2c(TS)

TASK: TEST WIRING HARNESS

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVERS, SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-2a(TS)<br>AS IN VIII-A-2b(TS) |
| 4. TEST WIRING HARNESS | 1. CAVITY BY CAVITY<br>2. TURN IGNITION SWITCH TO ON POSITION<br>3. CONNECT VOLTMETER NEGATIVE LEAD TO CAVITY NO. 1 IN WIRING HARNESS<br>4. CONNECT VOLTMETER POSITIVE LEAD TO CAVITY NO. 1 IN WIRING HARNESS<br>NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE, ALL ACCESSORIES OFF. IF DIFFERENT, CHECK CIRCUIT<br>5. ATTACH POSITIVE LEAD OF VOLTMETER TO HARNESS CONNECTOR NO. 2<br>6. NEGATIVE LEAD TO GROUND<br>NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE WITH ALL ACCESSORIES OFF, IF DIFFERENT CHECK CIRCUIT<br>7. LEAVE NEGATIVE LEAD GROUNDED<br>8. ATTACH POSITIVE LEAD OF VOLTMETER TO FINAL HARNESS CONNECTOR CAVITY NO. 3<br>NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE. IF DIFFERENT, CHECK OUT THE CIRCUIT |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: THE WIRING HARNESS CHECK IS NOW COMPLETE. HARNESS CONNECTORS NOS. 1, 2, AND 3 ARE TESTED WITH A VOLTMETER WITH IGNITION SWITCH IN "ON" POSITION AND CAVTIES NOS. 4 AND 5 (WHICH CHECK OUT THE PICK-UP COIL) ARE TESTED WITH AN OHMMETER WITH THE IGNITION SWITCH "OFF" |

TASK SHEET CHRYSLER VIII-A-2d(TS)

TASK: BALLAST RESISTOR TEST

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVER, AND SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-2(TS) |
| 4. BALLAST RESISTOR TEST | 1. HOOK UP OHMMETER AND MEASURE EACH SIDE OF BALLAST RESISTOR IN TURN<br>2. COMPENSATING (COIL) SIDE SHOULD READ BETWEEN .50 AND .80 OHMS<br>3. AUXILIARY (CONTROL UNIT) SIDE READING SHOULD BE BETWEEN 4.75 AND 5.75 OHMS<br>NOTE: IF NEITHER ONE OF THE READINGS IS OBTAINED, REPLACE BALLAST |

TASK SHEET CHRYSLER VIII-A-2e(TS)

TASK: TEST IGNITION COIL

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, FENDER COVERS, SEAT COVERS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, PARTS CLEANER AND RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | SEE VIII-A-2(J) |
| 4. IGNITION COIL TEST | NOTE: PRIMARY RESISTANCE ON A CHRYSLER PRESTOLITE COIL SHOULD BE BETWEEN 1.6 AND 1.79 OHMS. ON A CHRYSLER ESSEX COIL, PRIMARY RESISTANCE SHOULD BE BETWEEN 1.41 AND 1.62 OHMS. SECONDARY RESISTANCE ON CHRYSLER PRESTOLITE COILS SHOULD BE BETWEEN 9,400 AND 11,700 OHMS<br>NOTE: IF NEITHER ONE OF THESE READINGS IS OBTAINED, REPLACE THE COIL |

# INFORMATION SHEET
# ON
# ELECTRONIC IGNITION

SUBJECT: Electronic Ignition System

## INTRODUCTORY INFORMATION:

The Ford solid state ignition system contains an electronic module which is the controlling element for the system. The distributor is new and points and condenser have been replaced by an armature and stator. The coil is now oil filled. A volt-ohmmeter tester is the only test equipment needed for the ignition system diagnosis.

Wires for the system are color coded. Battery power is supplied to the module from the ignition switch through the white wire when the engine is cranked. After the engine is started and running, battery power is supplied to the module through the red wire. Distributor signals are received at the module through the orange and purple wires. Primary ignition is received from the coil through the green wire.

Primary ignition current is transmitted to the distributor and ground through the black wire. Ignition system protection is provided by the blue wire.

As the ignition switch is turned on, primary current flows through the resistor circuit, to the coil, on to the module and to ground. When the engine is turned over and the distributor shaft rotates there are signals generated by the distributor which cause the module to break the primary current flow. As the module breaks the primary current flow secondary voltage is induced in the coil causing the spark plug to fire. The module timing circuit turns the primary current on again and the coil is energized for the next spark cycle. Dwell measurement is meaningless in this system because dwell varies with engine speed and there is no means of altering or controlling it.

The ignition process for this system is very much like the breaker point system; however, it requires more wiring and equipment. It is much more reliable, accurate, and there is little or no maintenance for the primary ignition system. The system has a secondary output within the ranges of the conventional breaker point system.

The spark plug gap for the electronic ignition system has been changed. It varies from .044" to .054", but for the most part a .044" gap is used. However, to be on the safe side refer to the manufacturer's specifications when performing spark plug service.

## GENERAL INFORMATION

The module is the heart of the Ford solid state ignition system. The module cannot be repaired. It must be replaced if it becomes defective. The case is made of aluminum and is the heat sink. All parts are assembled in the case and tested. The parts are sealed in the case in a mixture of sand and epoxy. This construction renders the module impervious to shock and temperatures from normal automotive use. The wire leads are the most vulnerable parts of the module.

The new distributor is similar in appearance to the breaker point distributor but it has the following construction differences.

A. The primary wiring hole is now a slot.

B. The diaphragm assembly control rod is different.

C. The cam and advance plate assembly have been replaced by a sleeve and plate assembly.

D. The upper and lower spring loaded base plate assembly has been replaced by a base plate mounted on the base casting. On the base plate the magnetic pickup assembly has been fitted. The pickup unit is secured to the base plate with a fine wire retaining ring.

E. The center post breaker cam has been replaced by an armature. The armature is secured to the sleeve and plate by aligning slots and inserting a roll pin.

F. The armature can be removed by pulling up on it.

The oil filled coil is blue or has a blue top on it. It is also taller than the tar filled type. Terminals are labeled BAT (battery) and DEC (distributor electronic control). This type coil's output and performance characteristics differ from the old conventional coil.

This new oil filled coil must be tested separate from the other ignition components. It can be tested on any standard coil tester according to manufacturer's specifications.

A volt-ammeter tester or a type that utilizes a knife switch at the battery terminal is not to be used for alternator output test on a vehicle equipped with solid state ignition, for destructive damage can be caused. For alternator output testing on vehicles equipped with the solid state ignition system use the volt-ohmmeter test procedure. However, the system is protected against electrical current produced or used under normal vehicle operating conditions.

As on the breaker point system the spark intensity test is used for the solid state system to isolate ignition problems. Follow the procedure:

1. Remove the coil to distributor high tension lead from the distributor tower

2. Connect an auxiliary starter switch into the starting circuit

3. Turn the ignition switch to the "on" position

4. Hold the distributor end of the high tension lead with high tension pliers about 3/16" from cylinder head or a good ground

5. Crank the engine over with the auxiliary starter switch
   NOTE: If the spark is good the trouble is in the primary circuit. If no spark or it is weak check the coil to distributor high tension lead for good condition.
   NOTE: No test is to be made at the module terminals at this time. Disconnect the three-way and four-way connectors at the electronic module. Install a new module. If the trouble is not corrected, reinstall the original module and check the remaining ignition system components.
   CAUTION: The grease on the engine harness connector is not to be removed as this grease is used as a corrosion inhibitor.

The test to determine that the module is receiving correct battery voltage is referred to as the module bias test. Performed as follows:

1. Disconnect the four-way connector at the module

2. Connect a voltmeter between a good ground and pin hole 3 (red lead) of the connector

3. Turn the ignition switch to the "on" position

4. Observe voltmeter reading
   NOTE: If the voltmeter reading is less than battery voltage, repair or replace the voltage feed wire to the module.

Battery to coil test or battery source test is performed as follows:

1. Connect a voltmeter between a good ground and the coil battery terminal. Coil is to remain connected as usual

2. Connect a jumper lead between the coil DEC terminal and a good ground

3. Turn all lights and accessories off

4. Turn the ignition switch to the "on" position
   NOTE: If the voltmeter reading is between 4.9 volts and 7.9 volts, the primary circuit from the battery to the coil is satisfactory.
   NOTE: If the voltmeter reading is less than 4.9 volts:
      a. Check primary wiring for worn insulation, broken strands, or loose and corroded terminals.

b. Check resistance wire for good condition.

NOTE: If the voltmeter reading is greater than 7.9 volts:

a. Verify resistance wire condition.

b. Replace resistance wire.

Cranking circuit test:

1. Connect voltmeter between a good ground and pin hole 1 (white lead) of the four-hole connector

2. Turn ignition switch to "on" position

3. Crank engine over with auxiliary starter switch
   NOTE: If the voltmeter reading is not 8 to 12 volts, repair or replace the voltage lead to the module.

Starting circuit test

1. Connect the voltmeter between a good ground and pin hole 5 (green wire) of the three-hole connector

2. Turn the ignition to the "on" position

3. Crank engine over with auxiliary starter switch
   NOTE: If the voltage reading is not between 8 to 12 volts:
   a. Ignition bypass circuit is open or grounded from either the starter solenoid, the ignition switch to pin hole 5 (green wire), or primary coil connection.
   b. Repair or replace leads as required.

Magnetic pickup or stator test

1. Disconnect the three-wire connector at the distributor pigtail

2. Connect a DC voltmeter on the 2.5 volt scale between the two parallel blades in the male part of the connector (orange and purple wires)

3. Turn ignition to "on" position

4. Crank the engine over -- the meter needle should oscillate

5. Turn off ignition switch

6. Remove voltmeter

7. Connect an ohmmeter between the two parallel blades (orange and purple leads)

NOTE: This distributor connection should read 400 to 800 ohms.

8. Remove one lead of ohmmeter from a blade and connect it to a good ground
   NOTE: Resistance between either blade and ground must be greater than 70,000 ohms.

9. Connect ohmmeter between third blade (black lead) and good ground on distributor housing
   NOTE: Resistance between third lead and distributor housing must be "0".
   NOTE: If any one test fails the distributor magnetic pickup (stator assembly) is not functioning properly and should be replaced.
   NOTE: If troubles persist
      a. Remove distributor cap
      b. Visually and by feel check distributor for damages or misassembly
         (1) Armature must be sintered
         (2) Armature must be tight on sleeve
         (3) Roll pin securely in position
         (4) Sintered iron stator is not broken
         (5) Armature rotates when engine is cranked over

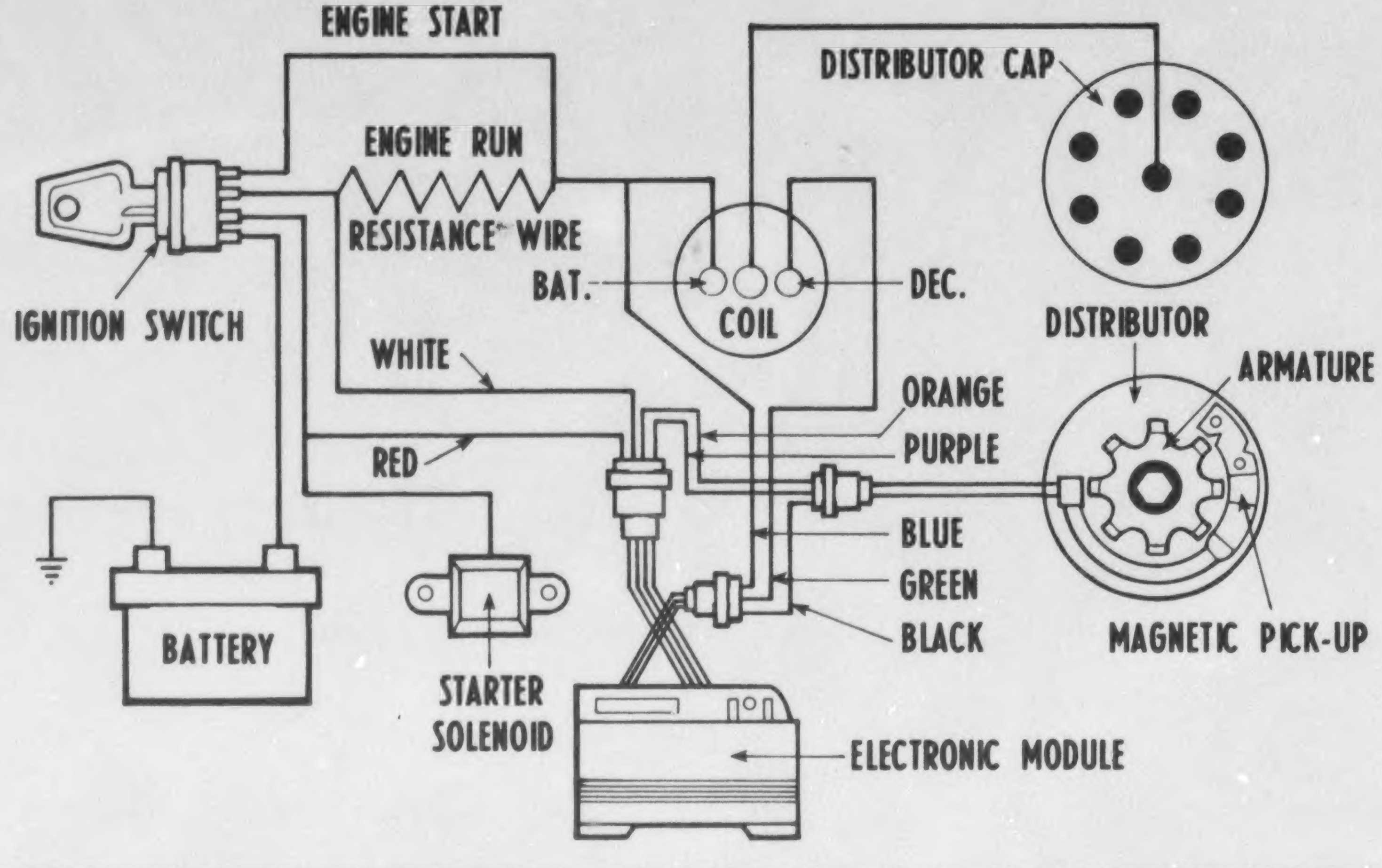
Short or ground test

1. Connect ohmmeter between pin hole 5 (red lead) of the 4 wire connector and a good ground
   NOTE: If the resistance is less than 4 ohms:

2. Check for a short at the DEC terminal of the coil to ground

3. Check primary winding of coil
   NOTE: If resistance reading is out of specifications replace primary wire.

# FORD SOLID STATE IGNITION


ENGINE START
DISTRIBUTOR CAP
ENGINE RUN
RESISTANCE WIRE
BAT.
COIL
DEC.
IGNITION SWITCH
DISTRIBUTOR
ARMATURE
WHITE
ORANGE
PURPLE
RED
BLUE
GREEN
BLACK
BATTERY
STARTER
SOLENOID
MAGNETIC PICK-UP
ELECTRONIC MODULE

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | TEST AND SERVICE ELECTRONIC IGNITION SYSTEM (FORD) |
| AIM: | THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF FORD'S ELECTRONIC IGNITION SYSTEM, TO DETERMINE NEEDED ADJUSTMENTS OR REPLACEMENT OF SPECIFIC PARTS OF THE IGNITION SYSTEM; USING THE TOOLS AND TEST EQUIPMENT CALLED FOR IN THE TASK |
| TOOLS AND EQUIPMENT: | HAND TOOLS, VOLT-OHMMETER, TEST LEADS, FENDER COVERS, SEAT COVERS, DROPLIGHT, AND INSULATED PLIERS |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | WIRING DIAGRAMS, MANUFACUTERER'S REPAIR MANUAL, EXPLODED VIEWS OF COMPONENTS<br>JOB VIII-A-3(TS) FORD AND TASK SHEETS |
| REFERENCES: | AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436<br>MOTOR, NOVEMBER 1974, PP. 25, 53, AND 57<br>FORD SERVICE MANUALS |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENTS MUST HAVE STUDIED JOB SHEET VIII-B-2(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON IGNITION SYSTEMS AND COMPONENTS |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. OBSERVE SAFETY RULES<br>3. PREPARATION AND HOOKUP OF TEST EQUIPMENT<br>4. USE OF TEST EQUIPMENT<br>5. TEST RESULTS ACCORDING TO SPECIFICATIONS<br>6. USE OF TOOLS AND EQUIPMENT<br>7. AN ATTITUDE OF APPRECIATION FOR CUSTOMER'S VEHICLE<br>8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

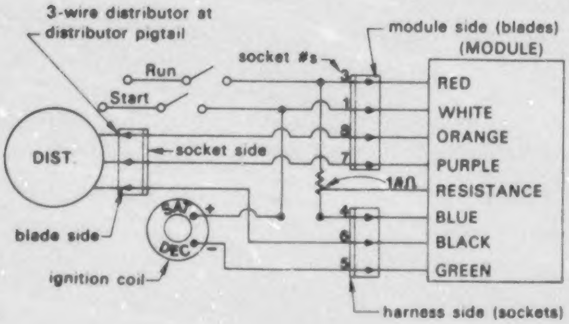
WHEN ABNORMAL OPERATION IS NOTED IN STARTING AND RUNNING OF A VEHICLE, IT IS NECESSARY TO DETERMINE WHICH SYSTEM IS AT FAULT

DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF TESTS AND INSPECTIONS WHICH WILL POINT OUT COMPONENTS OF THE AUTOMOTIVE ELECTRICAL SYSTEM THAT MAY BE AT FAULT IN CONTROLLING THE IGNITION SYSTEM. HOOKUP OF TEST EQUIPMENT, TESTING PROCEDURES, AND RECOM-

MENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHCILE | 1. POSITION VEHICLE AS IN PRECEDING TASKS<br>2. RAISE HOOD AND INSTALL FENDER COVERS |
| 2. PRELIMINARY CHECK | 1. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS TO IGNITION COIL<br>2. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT DISTRIBUTOR<br>3. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT MODULE |
| 3. SPARK INTENSITY TEST AT COIL | 1. DISCONNECT THE HIGH-TENSION WIRE FROM CENTER OF DISTRIBUTOR TOWER<br>2. HOLD WIRE (WTIH INSULATED PLIERS) ABOUT $\frac{1}{4}$ INCH AWAY FROM A GOOD GROUND<br>3. CRANK ENGINE<br>NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP REGULARLY<br>4. REPLACE HIGH TENSION WIRE IN DISTRIBUTOR TOWER<br>5. REMOVE SPARK PLUG WIRE FROM THE SPARK PLUG<br>6. HOLD WIRE ABOUT $\frac{1}{4}$ INCH FROM ENGINE GROUND WITH A PAIR OF INSULATED PLIERS<br>CAUTION: NEVER PULL NO. 1 OR NO. 5 ON THE 6 CYLINDER ENGINE; NO. 2 OR NO. 4 ON A V6 ENGINE; NO. 1 OR NO. 3 ON A 4 CYLINDER ENGINE: OR NO. 1 OR NO. 8 ON AN 8 CYLINDER ENGINE. IT CAN CAUSE DAMAGE TO THE DISTRIBUTOR BY INTERNAL ARCING |


3-wire distributor at distributor pigtail
module side (blades)
(MODULE)
socket #s
Run
Start
DIST.
socket side
blade side
ignition coil
SAT
DEC
+
−
3
1
8
7
18Ω
4
6
5
RED
WHITE
ORANGE
PURPLE
RESISTANCE
BLUE
BLACK
GREEN
harness side (sockets)

7. CRANK THE ENGINE

NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP

NO START TEST

4. PREPARE BATTERY

1. REMOVE BATTERY TERMINAL LEADS
2. THOROUGHLY CLEAN AND SERVICE
3. INSTALL BATTERY TERMINAL LEADS AND TIGHTEN SECURELY

5. MODULE BIAS TEST

NOTE: POWER TO OPERATE

1. TURN IGNITION KEY ON
2. CONNECT VOLTMETER NEGATIVE LEAD TO A GOOD GROUND
3. CONNECT VOLTMETER POSITIVE LEAD
4. PROBE TO SOCKET NO. 3 ON HARNESS SIDE

NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT

6. BATTERY SOURCE TEST

1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO GOOD GROUND
2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE

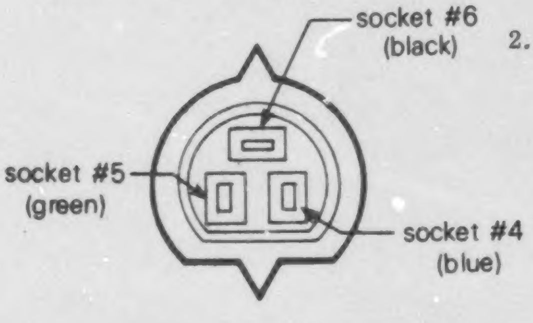
NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT

7. CRANKING TEST

1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO A GOOD GROUND
2. CONNECT VOLTMETER POSITIVE TEST LEAD PROBE TO SOCKET NO. 1 ON HARNESS SIDE

NOTE: BATTERY VOLTAGE SHOULD BE 8 TO 12 VOLTS

8. STARTING CIRCUIT TEST



1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO A GOOD GROUND
2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE

NOTE: BATTERY VOLTAGE SHOULD BE 8 TO 12 VOLTS D.C.

9. DISTRIBUTOR HARDWARE TEST

1. CONNECT VOLTMETER NEGATIVE TEST LEAD PROBE TO HARNESS SOCKET NO. 7
2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO HARNESS SOCKET NO. 8
3. CRANK ENGINE

CAUTION: LIMIT CRANKING TIME TO 15 SECOND INTERVALS

NOTE: ANY WIGGLE OF THE NEEDLE ON VOLTMETER DIAL IS OK, OR AT LEAST ½ VOLT READING ON A.C. SCALE

10. STATOR TEST

1. TURN IGNITION KEY TO OFF POSITION
2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 7 AND SOCKET NO. 8

NOTE: RESISTANCE SHOULD BE 400 TO 800 OHMS

3. CONNECT OHMMETER PROBES TO SOCKET NO. 6 AND TO ENGINE GROUND

NOTE: RESISTANCE SHOULD BE ZERO OHMS

4. CONNECT OHMMETER PROBES TO SOCKET NO. 7 AND TO ENGINE GROUND

NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS

5. CONNECT OHMMETER PROBES TO SOCKET NO. 8 AND TO ENGINE GROUND

NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS

11. COIL TEST

1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 3 AND TO IGNITION COIL TOWER

NOTE: RESISTANCE SHOULD BE 7,000 TO 13,000 OHMS

2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 5 AND NO. 4

NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS

| | |
|---|---|
| 12. SHORT TEST | 1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 5 AND TO ENGINE GROUND<br>NOTE: RESISTANCE SHOULD BE MORE THAN 4.0 OHMS |
| 13. RESISTANCE WIRE TEST | 1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKETS NO. 3 AND NO. 4<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS<br>CAUTION: DO NOT USE THE VOLT-AMP TEST METHOD OR TEST PROCEDURE OR ANY TEST EQUIPMENT WHEREIN A SWITCH IS USED AT THE BATTERY TERMINAL |
| 14. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION
2. STUDENTS TO USE JOB AND TASK SHEETS
3. RETEACH WHEN THE NEED ARISES
4. ASK QUESTIONS ABOUT STEPS ANY KEY POINTS AS STUDENTS PERFORM TASKS

## IV. VERIFICATION AND OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. STUDENTS TO BE PLACED ON THEIR OWN TO PERFORM JOB
2. USE PERFORMANCE TEST
3. CHECK STUDENTS FOR ACCURACY OF RESULTS
4. POST THE RESULTS ON PROGRESS CHART

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE THE IMPORTANCE OF USING THE CORRECT TEST INSTRUMENT FOR THE JOB
2. EMPHASIZE THE IMPORTANCE OF KNOWING WHICH SPARK PLUG WIRE NOT TO REMOVE FOR ENGINE RUNNING TESTS
3. EMPHASIZE SAFE WORK HABITS
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ SCHEMATIC DIAGRAMS

5. EMPHASIZE THE IMPORTANCE OF FOLLOWING STEP BY STEP TESTING PROCEDURES
6. REPEAT AREAS TO BE TESTED FROM STAGE II OF THE LESSON
7. DRILL STUDENTS ON KEY POINTS FOR EACH TEST

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 289-294
AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
MOTOR, NOVEMBER, 1974, PP. 25, AND 56-57
FORD MOTOR CO. SERVICE MANUALS, IGNITION SERVICE

THE NEXT LESSON IS: VIII-A-4(S), "TEST & SERVICE ELECTRONIC (H.E.I.) IGNITION SYSTEM" (GENERAL MOTORS)

VIII-A-3(J)

# JOB SHEET
# IN
# ELECTRONIC IGNITION SYSTEM

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVERS, DROP LIGHT, HAND TOOLS, VOLTMETER, OHMMETER, INSULATED PLIERS, TEST LEAD PROBES, AND SPARK PLUG ADAPTORS

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB, READ REFERENCE MATERIAL, STUDY JOB AND TASK SHEETS. BE SURE FENDER AND SEAT COVERS ARE IN POSITION ON VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT

BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT IGNITION SYSTEM PROBLEMS

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-A-3(TS) | TEST SPARK INTENSITY |
| VIII-A-3a(TS) | MODULE BIAS TEST |
| VIII-A-3b(TS) | BATTERY SOURCE TEST |
| VIII-A-3c(TS) | TEST DISTRIBUTOR HARDWARE |
| VIII-A-3d(TS) | TEST STATOR |
| VIII-A-3e(TS) | COIL TEST |
| VIII-A-3f(TS) | SHORT TEST |
| VIII A-3g(TS) | TEST RESISTANCE WIRE |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOK-UP AND TEST RESULTS

SERVICE STORAGE BATTERY
TEST STORAGE BATTERY
CLEAN WORK STATION

TASK SHEET FORD VIII-A-3 (TS)

**TASK:** TEST SPARK INTENSITY

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLT-METERS, 20,000 VOLT-OHM RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROP-LIGHT, INSULATED PLIERS, SEAT COVERS, AND FENDER COVERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT IGNITION COIL<br>2. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT DISTRIBUTOR<br>3. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT THE MODULE |
| 4. SPARK INTENSITY TEST AT COIL | 1. DISCONNECT HIGH TENSION WIRE FROM CENTER OF DISTRIBUTOR TOWER<br>2. HOLD WIRE (WITH INSULATED PLIERS) ABOUT $\frac{1}{4}$ INCH AWAY FROM A GOOD GROUND<br>3. CRANK ENGINE OVER<br>NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP REGULARLY<br>4. REPLACE HIGH TENSION WIRE IN DISTRIBUTOR TOWER<br>5. REMOVE SPARK PLUG WIRE FROM A SPARK PLUG<br>6. HOLD WIRE ABOUT $\frac{1}{4}$ INCH FROM THE ENGINE GROUND WITH A PAIR OF INSULATED PLIERS<br>CAUTION: NEVER PULL NO. 1 OR NO. 5 ON THE SIX CYLINDER ENGINE; NO. 2 OR NO. 4 ON THE V6 ENGINE; NO. 1 OR NO. 3 |

| STEPS | KEY POINTS |
|---|---|
| | ON THE FOUR CYLINDER ENGINE; NO. 1 OR NO. 8 ON THE EIGHT CYLINDER ENGINE |
| | 7. CRANK THE ENGINE OVER |
| | NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP |

TASK SHEET FORD VIII-A-3a(TS)

| | |
|---|---|
| TASK: | MODULE BIAS TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLT-OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROP-LIGHT, INSULATED PLIERS, FENDER COVERS, AND SEAT COVERS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. MODULE BIAS TEST | 1. TURN IGNITION KEY ON<br>2. CONNECT VOLTMETER NEGATIVE LEAD TO A GOOD GROUND<br>3. CONNECT VOLTMETER POSITIVE LEAD PROVE TO SOCKET NO. 3 ON HARNESS SIDE<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT<br>4. TURN IGNITION KEY OFF |

TASK SHEET FORD VIII-A-3b(TS)

| | |
|---|---|
| TASK: | BATTERY SOURCE TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROPLIGHT, INSULATED PLIERS, FENDER COVERS, AND SEAT COVERS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-A-1(TS) |
| 4. BATTERY SOURCE TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO GOOD GROUND<br>2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE<br>3. TURN IGNITION SWITCH "ON"<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT<br>4. TURN IGNITION SWITCH "OFF" |

TASK SHEET FORD VIII-A-3c(TS)

| | |
|---|---|
| TASK: | TEST DISTRIBUTOR HARDWARE |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT BATTERY, INSULATED PLIERS, REMOTE STARTER CONTROL SWITCH, DROPLIGHT, FENDER COVERS, SEAT COVERS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-A-2(TS) |
| 4. DISTRIBUTOR HARDWARE TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD PROBE TO HARNESS SOCKET NO. 7 |
| | 2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 8 |
| | 3. CONNECT REMOTE STARTER CONTROL SWITCH IN STARTING CIRCUIT<br>a. ATTACH ONE LEAD TO SOLENOID BATTERY TERMINAL<br>b. REMOVE IGNITION START AND TRANSMISSION NEUTRAL SWITCH WIRES FROM STARTER SOLENOID TERMINALS<br>c. ATTACH OTHER REMOTE STARTER CONTROL SWITCH LEAD TO START TERMINAL ON STARTER SOLENOID |
| | CAUTION: NEUTRAL SWITCH WIRE MUST BE DISCONNECTED WHEN USING REMOTE STARTER CONTROL ON AUTOMATIC TRANSMISSION EQUIPPED VEHICLES |
| | 4. TURN IGNITION SWITCH "ON" |
| | 5. CRANK ENGINE OVER, USING REMOTE STARTER CONTROL SWITCH |
| | CAUTION: LIMIT CRANKING TIME TO 15 SECOND INTERVALS |

TASK SHEET FORD VIII-A-3d(TS)

|  |  |
|---|---|
| TASK: | TEST STATOR |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, INSULATED PLIERS, REMOTE STARTER CONTROL SWITCH, DROPLIGHT, FENDER COVERS, SEAT COVER |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-A-2(TS) |
| 4. TEST STATOR | 1. TURN IGNITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 7 AND TO SOCKET NO. 8<br>3. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 400 TO 800 OHMS<br>4. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 6<br>5. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND<br>6. OBSERVE OHMMETER READING<br>NOTE: READING SHOULD BE ZERO<br>7. CONNECT OHMMETER PROBE TO SOCKET NO. 7<br>8. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND<br>9. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS<br>10. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 8 |

| STEPS | KEY POINTS |
|---|---|
| | 11. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND |
| | 12. OBSERVE OHMMETER READING |
| | NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS |

TASK SHEET FORD VIII-A-3e(TS)

| | |
|---|---|
| TASK: | COIL TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY INSULATED PLIERS, FENDER COVERS, SEAT COVER, CLEAN RAG, DROPLIGHT |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-A-2(TS) |
| 4. COIL TEST | 1. TURN IGNITION SWITCH TO OFF POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 3<br>3. CONNECT OTHER OHMMETER TEST LEAD PROBE TO IGNITION COIL TOWER<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 7,000 TO 13,000 OHMS<br>5. CONNECT OHMMETER TEST LEAD TO SOCKET NO. 4<br>6. CONNECT OTHER OHMMETER TEST LEAD PROBE TO SOCKET NO. 5<br>7. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 |

TASK SHEET FORD VIII-A-3f(TS)

| | |
|---|---|
| TASK: | SHORT TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | DROPLIGHT, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, INSULATED PLIERS, HAND TOOLS, FENDER COVERS, SEAT COVER |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-A-2(TS) |
| 4. SHORT TEST | 1. TURN IGNITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 5<br>3. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND ON ENGINE<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE MORE THAN 4.0 OHMS |

TASK SHEET FORD VIII-A-32(TS)

TASK: TEST RESISTANCE WIRE

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: DROPLIGHT, HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF BATTERY, FENDER COVERS, SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-A-2(TS) |
| 4. RESISTANCE WIRE TEST | 1. TURN IGNITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 3<br>3. CONNECT OTHER OHMMETER TEST LEAD PROBE TO SOCKET NO. 4<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS<br>CAUTION: DO NOT USE VOLT-AMP. METHOD OF TEST PROCEDURE OR ANY TEST EQUIPMENT WHEREIN A KNIFE SWITCH IS USED AT THE BATTERY TERMINAL |

# INFORMATION SHEET ON IGNITION SYSTEM

GM VIII-A-4(IS)

SUBJECT: Electronic Ignition System (HEI)

INTRODUCTORY INFORMATION:

The General Motors High Energy Ignition System differs from other ignition systems in that:

A. The coil is built into the distributor cap.
B. The coil to distributor high tension lead has been eliminated.
C. Spark plug high tension leads have been increased by 1mm in diameter from 7mm to 8mm. This additional increase in diameter is insulation. This additional insulation is to prevent voltage loss as the lead must withstand about 35,000 volts.
D. There is no primary resistance wire. The module furnishes full battery power to the ignition coil.
E. Included in the distributor is a capacitor. This capacitor is not a part of the ignition system; it is a noise suppressor for the radio.

The system requires special plugs which have about an .080" air gap. But when servicing spark plugs refer to the manufacturer's specifications.

## GENERAL INFORMATION

The electronic module is a solid-state unit that contains five complete circuits which trigger the spark, switches, limits current, angle of dwell, and distributor pickup. The angle of dwell varies with the engine speed.

The conventional distributor housing contains the electronic module, radio noise capacitor, and the magnetic pickup assembly.

The magnetic pick up assembly is made up of the pick up coil plate, a permanent magnet, pick up coil, and a pole plate. This assembly is mounted over the main bearing on the distributor housing. The pick up coil plate is made to rotate by the vacuum-control unit which provides vacuum advance.

A timer core with teeth according to the number of cylinders is made to rotate with the distributor shaft. Also, it rotates on the distributor shaft controlled by conventional advance weights; therefore, centrifugal advance is provided.

When timer core external teeth match up with the internal teeth of the pole plate, voltage is induced inside the pick up coil and a signal is sent to the module to open and close the primary circuit in the ignition coil. This happens each time the distributor shaft rotates according to the number of cylinders in the engine. The primary circuit decreases and a high voltage is induced in the coil secondary winding. The high voltage is directed through the rotor, distributor cap, high tension leads, and spark plugs causing fire to ignite the fuel.

Trouble in the HEI system will appear in two ways. An engine will not start or it runs rough. The HEI system can be checked on or off the vehicle. When the system is checked off the vehicle a distributor tester can be used, but to do this a distributor pulse amplifier, an ohmmeter, and a coil tester must be added on. Follow the equipment manufacturer's specifications when testing the system with this method.

The HEI system can be tested with an oscilloscope in much the same manner as the breaker point system. However, be sure to follow specifications.

To check the HEI system of the vehicle first check the wiring connector for tight and clean. Make sure all spark plug high tension leads are in good shape and properly installed.

If the engine will not start:

1. Disconnect the connector from the distributor cap.
2. Connect a voltmeter between the battery terminal in the connector and a good ground.
3. Turn the ignition switch to the "on" position.
   NOTE: Engine is not to be cranked over.
4. Observe the meter reading.
   NOTE: If the reading is zero there is an open circuit in one of the following:
   A. The lead between the distributor and the bulkhead connector.
   B. The lead between the bulkhead connector and the ignition switch.
   C. The red lead between the ignition switch and the starter solenoid.
   NOTE: If the meter reading is the same as the battery voltage:
   A. Remove a spark plug high tension lead at the spark plug.
   B. Hold the lead with high tension pliers about 1/4" from a good ground.
   C. Crank the engine over.
   NOTE: If there is a good spark the trouble is either spark plugs or fuel.
   NOTE: If there is no spark, ignition system components must be checked.

Check Distributor Cap and Rotor

1. Remove distributor cap and coil assembly from distributor housing.
2. Remove wiring harness connector.
3. Remove battery lead.
4. Turn cap upside down.
5. Examine spark plug terminals in cap.
6. Examine high tension carbon button.
7. Examine connector terminals.
8. Make sure that there are no arc-over signs on cap or rotor.
   NOTE: If there are signs of arcing replace faulty component.

Test Coil

1. Connect one ohmmeter lead to battery terminal as indicated on the distributor cap.
2. Observe meter reading.

   NOTE: If meter reading is not zero replace the coil.

   NOTE: If the meter reading is zero:

   1. Turn ohmmeter selector scale to middle or high range.
   2. Connect ohmmeter between the tach terminal and the coil high tension output lead (center carbon button in distributor cap).
   3. Observe meter reading.

   NOTE: If the reading is infinite, replace the coil.

   NOTE: If the meter reading is not infinite, a check of the pick up coil is made.

Pick Up Coil Test

1. Disconnect pick up coil leads, W and G, to module.
2. Set ohmmeter on middle scale.
3. Connect the ohmmeter between a good ground and one pick up coil lead.
4. Observe meter reading.

   NOTE: If the meter reading is not infinite replace the pick up coil.

   NOTE: If the meter reading is infinite:

   1. Connect vacuum tester to vacuum advance.
   2. Operate vacuum tester moving the pick up coil through its entire range.
   3. Observe meter reading.

   NOTE: If the meter reading does not remain infinite at all times replace the pick up coil.

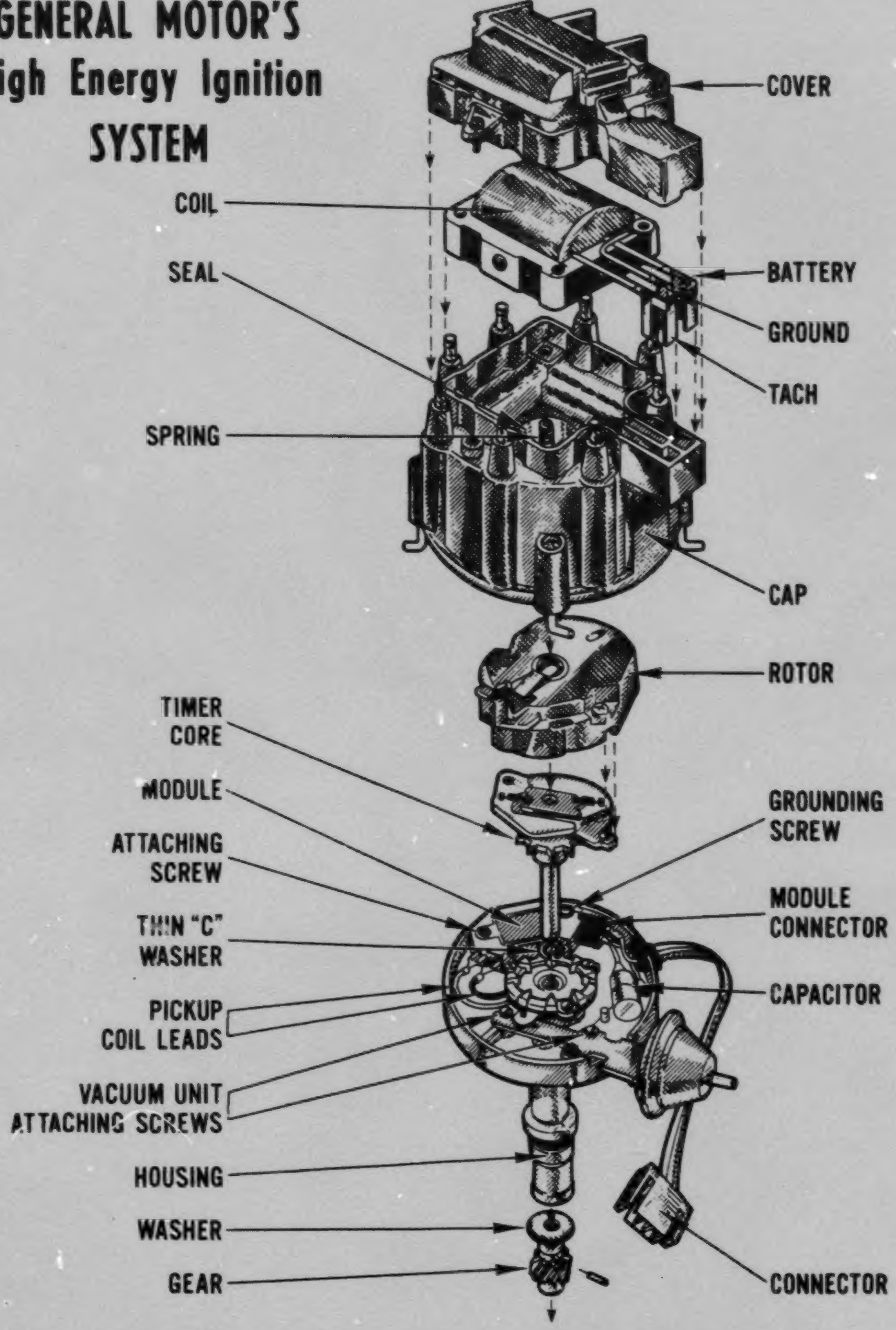
   NOTE: If the meter reading is infinite at all times for both previous tests:

   1. Connect ohmmeter between both pick up coil leads.
   2. Operate vacuum tester moving the pick up coil through its full range.
   3. Observe the ohmmeter.

   NOTE: If the meter reading is less than 650 ohms or more than 850 ohms at any time during the test, replace the pick up coil.

   NOTE: If the preceding pick up coil tests all prove to be negative replace the module. However, if the module does not correct the problem replace the pick up coil magnet. In case the magnet loses its magnetism no voltage will be induced in the pick up coil and, therefore, the module will receive no signal to open or close the primary circuit in the coil; so, the engine will not start.

# GENERAL MOTOR'S High Energy Ignition SYSTEM


COVER
COIL
BATTERY
SEAL
GROUND
TACH
SPRING
CAP
ROTOR
TIMER CORE
MODULE
GROUNDING SCREW
ATTACHING SCREW
MODULE CONNECTOR
THIN "C" WASHER
CAPACITOR
PICKUP COIL LEADS
VACUUM UNIT ATTACHING SCREWS
HOUSING
WASHER
GEAR
CONNECTOR

# INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** TEST AND SERVICE ELECTRONIC, (H.E.I.), IGNITION SYSTEM (GENERAL MOTORS)

**AIM:** THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF GENERAL MOTOR'S ELECTRONIC IGNITION SYSTEM, TO DETERMINE NEEDED ADJUSTMENTS, OR TO REPLACE SPECIFIC PARTS IN THE IGNITION SYSTEM: USING THE TOOLS AND TEST EQUIPMENT CALLED FOR IN THE TASK

**TOOLS AND EQUIPMENT:** HAND TOOLS, VOLT-OHMMETER, TEST LEADS WITH PROBES, FENDER COVERS, SEAT COVERS, DROPLIGHT AND INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE (HEI TYPE), VACUUM TESTER

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** WIRING DIAGRAMS, MANUFACTURER'S REPAIR AND SERVICE MANUAL, EXPLODED VIEWS OF THE COMPONENTS

**REFERENCES:**
AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
AUTOMECHANICS, PP. 289-294
MOTOR, OCTOBER, 1974 PP. 48, 49, 71, 91
GENERAL MOTORS SERVICE AND REPAIR MANUALS
VIII-A-2a(TS) JOB AND TASK SHEETS

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENTS MUST HAVE SATISFACTORILY COMPLETED PRECEDING TASKS IN MAJOR BLOCK VIII. STUDENTS MUST HAVE STUDIED JOB SHEET VIII-A-2(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON THE IGNITION SYSTEMS AND COMPONENTS

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. OBSERVE SAFETY RULES
3. PREPARATION AND HOOKUP OF THE TEST EQUIPMENT
4. THE USE OF TEST EQUIPMENT
5. TEST RESULTS ACCORDING TO SPECIFICATIONS
6. UNDERSTANDING THE NEED AND USE OF SPECIAL TOOLS AND EQUIPMENT
7. AN ATTITUDE OF APPRECIATION FOR CUSTOMER'S VEHICLE
8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN ABNORMAL OPERATION IS NOTED IN STARTING AND RUNNING OF A VEHICLE, IT IS NECESSARY TO MAKE CERTAIN CHECKS TO DETERMINE WHICH SYSTEM IS AT FAULT

DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF TESTS AND INSPECTIONS WHICH WILL POINT OUT COMPONENTS OF GENERAL MOTOR'S ELECTRONIC IGNITION SYSTEM (H. E. I.) THAT MAY BE AT FAULT IN CONTROLLING THE IGNITION SYSTEM. HOOKUP OF TEST EQUIPMENT TESTING PROCEDURES AND RECOMMENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED. SPECIAL CAUTIONS WILL BE GIVEN ON TEST HOOKUPS TO PREVENT DAMAGE TO THE IGNITION SYSTEM

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS<br>2. RAISE HOOD AND INSTALL FENDER COVERS |
| 2. PRELIMINARY CHECK | 1. CHECK WIRING CONNECTOR FOR SECURE AND PROPER ATTACHMENT TO SIDE OF DISTRIBUTOR CAP<br>2. CHECK SPARK PLUG LEADS FOR SECURE AND PROPER ATTACHMENT AT THE PLUGS<br>3. CHECK DISTRIBUTOR TERMINALS FOR CORROSION AND TIGHTNESS |
| 3. NO START CONDITION TEST | 1. REMOVE CONNECTOR FROM DISTRIBUTOR CAP<br>2. ATTACH VOLTMETER POSITIVE LEAD TO BATTERY TERMINAL IN CONNECTOR<br>3. ATTACH VOLTMETER NEGATIVE LEAD TO A GOOD GROUND<br>4. TURN IGNITION SWITCH TO RUN POSITION<br>NOTE: DO NOT CRANK ENGINE. NOTE THE VOLTMETER READING. IF THE VOLTAGE IS ZERO, THERE IS AN OPEN CIRCUIT IN ONE OR MORE OF THESE AREAS |

   a. WIRE BETWEEN THE DISTRIBUTOR AND BULKHEAD CONNECTOR
   b. WIRE BETWEEN THE BULKHEAD CONNECTOR AND IGNITION SWITCH
   c. BETWEEN THE IGNITION SWITCH (IN THE 10 GAUGE RED WIRE) AND STARTER SOLENOID

5. TURN IGNITION SWITCH OFF

4. COIL TEST

1. REMOVE WIRING HARNESS CONNECTOR AND BATTERY LEAD
2. TURN FOUR CAP-TO-HOUSING LATCHES ON THE DISTRIBUTOR CAP ¼ TURN COUNTERCLOCKWISE
3. LIFT OFF DISTRIBUTOR CAP AND COIL ASSEMBLY
4. TURN CAP AND COIL ASSEMBLY OVER SO THAT DISTRIBUTOR SPARKPLUG TERMINALS, THE COIL HIGH TENSION CARBON BUTTON, AND THE DISTRIBUTOR CONNECTOR TERMINAL ARE ALL FACING UP
5. CHECK FOR EVIDENCE OF SPARK ARC-OVER ON THE DISTRIBUTOR CAP AND ROTOR

   NOTE: IF EVIDENCE OF ARC-OVER IS FOUND, REPLACE FAULTY COMPONENT

6. ATTACH OHMMETER POSITIVE LEAD WIRE TO BATTERY TERMINAL ARE INDEXED ON DISTRIBUTOR CAP

   NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL

7. ATTACH NEGATIVE LEAD TO A GOOD GROUND

   NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL

8. TURN OHMMETER SIDE SELECTOR TO MIDDLE OR HIGH RANGE
9. ATTACH ONE OHMMETER LEAD TO THE TACHOMETER TERMINAL AND OTHER LEAD TO COIL OUTPUT LEAD, WHICH IS CARBON BUTTON LOCATED AT THE CENTER OF THE DISTRIBUTOR CAP

NOTE: IF OHMMETER READS INFINITE REPLACE COIL

5. PICK-UP COIL CHECK

1. DISCONNECT PICK-UP COIL LEADS GOING TO MODULE MARKED W&G
2. SET OHMMETER FOR MIDDLE SCALE READING
3. ATTACH OHMMETER POSITIVE LEAD TO A PICK - UP COIL LEAD
4. ATTACH OHMMETER NEGATIVE LEAD TO A GOOD GROUND

NOTE: IF OHMMETER READING IS NOT INFINITE, REPLACE THE PICK-UP COIL (SHOULD BE INFINITE ALL TIMES)

5. CONNECT VACUUM ADVANCE TO A VACUUM TESTER
6. ACTIVATE VACUUM UNIT BY USING THE VACUUM TESTER

NOTE: OBSERVE THE OHMMETER THROUGHOUT THE ENTIRE VACUUM RANGE. IT SHOULD REMAIN INFINITE AT ALL TIMES. IF IT DOES NOT REPLACE PICK-UP COIL

7. ATTACH OHMMETER LEAD WIRE TO ONE OF PICK-UP COIL LEAD WIRES
8. ATTACH OTHER OHMMETER LEAD WIRE TO REMAINING LEAD WIRE OF PICK-UP COIL

NOTE: IF THE READING IS LESS THAN 650 OR MORE THAN 850 OHMS AT ANY TIME WHILE THE VACUUM TESTER IS ACTIVATING THE ADVANCE UNIT, REPLACE PICK-UP COIL. IF NO FAULT HAS BEEN FOUND AT THIS POINT, REPLACE THE MODULE AND IF THE CONDITION STILL EXISTS, CHECK PICK-UP MAGNET

6. PICK-UP COIL MAGNET TEST

1. KEY STILL OFF
2. TOUCH MAGNET POLE WITH TIN OR LIGHT STEEL FEELER GAUGE BLADE

NOTE: MAGNETISM SHOULD BE STRONG ENOUGH TO HOLD BLADE TIGHTLY IN PLACE. IF NOT, REPLACE MAGNET

3. DISCONNECT TEST EQUIPMENT

CAUTION: CHECK GENERAL MOTOR'S HOOKUP RECOMMENDATIONS BEFORE ATTACHING ANY TEST INSTRUMENT FOR MEASURING ENGINE SPEED

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

ISSUE JOB SHEET VIII-B-2(J) GENERAL MOTORS. STUDENTS TO PRACTICE THE JOB AND TASKS INVOLVED IN TESTING AND SERVICING GENERAL MOTOR'S HIGH ENERGY IGNITION SYSTEM

SHOP ACTIVITIES TO BE UNDER CLOSE SUPERVISION OF INSTRUCTOR AND OF SUCH LENGTH THAT STUDENTS WILL BECOME FAMILIAR WITH AND SUCCESSFULLY PERFORM ALL TASKS

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PERFORMANCE TEST - PLACE STUDENTS ON THEIR OWN, UNDER ACTUAL SHOP CONDITIONS, TO TEST AND SERVICE AN AUTOMOBILE'S ELECTRONIC IGNITION SYSTEM

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REVIEW TEST PROCEDURES FROM JOB VIII-A-2a(TS)
2. EMPHASIZE IMPORTANCE OF AVAILABLE BATTERY VOLTAGE
3. EMPHASIZE IMPORTANCE OF STEP BY STEP TEST PROCEDURE
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ WIRING DIAGRAMS
5. EMPHASIZE IMPORTANCE OF IGNITION "OFF" AND "ON" POSITIONS
6. EMPHASIZE IMPORTANCE OF CLEAN AND TIGHT ELECTRICAL CONNECTIONS

SUGGESTED READING FOR STUDENTS:

AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
AUTOMECHANICS, PP. 289-294
MOTOR, OCTOBER, 1974, PP. 48-49, 71, 91
GENERAL MOTORS SERVICE AND REPAIR MANUALS

THE NEXT LESSON IS: VIII-A-5(S) "TEST STORAGE BATTERY"

JOB SHEET GENERAL MOTORS VIII-A-4(J)
IN
ELECTRONIC IGNITION SYSTEM

JOB: TEST ELECTRONIC IGNITION SYSTEM (H.E.I.)

MATERIALS: CLEAN RAGS

TOOLS AND EQUIPMENT: HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, 1 ½ VOLT BATTERY POWERED, FERROUS FEELER GAUGE, DROPLIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE (HEI TYPE), VACUUM TESTER, TEST LEADS WITH PROBES, FENDER COVERS, SEAT COVER

GENERAL INSTRUCTIONS: BEFORE STARTING THIS JOB, READ REFERENCE MATERIAL. STUDY JOB AND TASK SHEETS. BE SURE SEAT AND FENDERS ARE PROTECTED WTIH SUITABLE COVERS BEFORE STARTING THE JOB. THE JOB IS TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO ARRIVE AT TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT HEI SYSTEM PROBLEMS.

PROCEDURE AND/OR TASKS:

| | |
|---|---|
| VIII-A-4(TS) | GENERAL MOTORS, PRELIMINARY CHECK |
| VIII-A-4a(TS) | GENERAL MOTORS, NO START TEST |
| VIII-A-4b(TS) | GENERAL MOTORS, COIL TEST (IGN) |
| VIII-A-4c(TS) | GENERAL MOTORS, PICK-UP COIL TEST |
| VIII-A-4d(TS) | GENERAL MOTORS, PICK-UP COIL MAGNET TEST |

CHECK POINT: CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

SERVICE STORAGE BATTERY
TEST STORAGE BATTERY
CLEAN WORK STATION

TASK SHEET GENERAL MOTORS VIII-A-4(TS)

TASK: PRELIMINARY TEST

JOB: TEST ELECTRONIC IGNITION SYSTEM (H. E. I.)

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1 ½ VOLT BATTERY, TEST LEADS WITH PROBES, DROPLIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE (HEI TYPE), VACUUM TESTER, FENDER COVERS, SEAT COVER, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. AS PER VIII-A-3(J) STORAGE BATTERY TEST<br>2. CHECK WIRING CONNECTOR FOR SECURE AND PROPER ATTACHMENT TO SIDE OF DISTRIBUTOR CAP<br>3. CHECK SPARK PLUG LEADS FOR PROPER ATTACHMENT AT SPARK PLUGS<br>4. CHECK DISTRIBUTOR TERMINALS FOR CORROSION AND TIGHTNESS<br>NOTE: SPARK PLUG WIRE IS OF SPECIAL RESISTANCE TYPE CONSTRUCTION. USE CARE IN REMOVAL FROM PLUGS TO PREVENT PULLING OFF TERMINALS OR BREAKING CORE. CLEAN WITH CLOTH MOISTENED WITH KEROSENE OR VARSOL. INSPECT FOR CUTS, WORN SPOTS, AND BREAKS IN INSULATION. INSPECT TERMINALS FOR CORROSION, BREAKS, OR DISTORTION |

## TASK SHEET GENERAL MOTORS VIII-A-4a(TS)

| | |
|---|---|
| TASK: | NO START TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM - H. E. I. |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1½ VOLT BATTERY, TEST LEADS WITH PROBES, DROPLIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE - HEI TYPE, VACUUM TESTER, FENDER COVERS, SEAT COVERS, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-A-1(TS) GENERAL MOTORS |
| 4. NO START CONDITION TEST | 1. REMOVE CONNECTOR FROM DISTRIBUTOR CAP<br>2. ATTACH VOLTMETER POSITIVE LEAD TO BATTERY TERMINAL IN CONNECTOR<br>3. ATTACH VOLTMETER NEGATIVE LEAD TO GOOD GROUND<br>4. TURN IGNITION SWITCH TO "ON" POSITION<br>NOTE: DO NOT CRANK ENGINE OVER<br>5. NOTE VOLTMETER READING<br>NOTE: IF THE VOLTAGE IS ZERO, THERE IS AN OPEN CIRCUIT IN ONE OR MORE OF THESE AREAS:<br>a. 18 PINK WIRE BETWEEN BULKHEAD CONNECTOR AND DISTRIBUTOR<br>b. 12 PINK WIRE BETWEEN IGNITION SWITCH AND BULKHEAD CONNECTOR<br>c. 10 RED WIRE BETWEEN BULKHEAD CONNECTOR AND STARTER SOLENOID<br>6. TURN IGNITION SWITCH OFF |

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| STEPS | KEY POINTS |
|---|---|
| | NOTE: IF READING IS BATTERY VOLTAGE AND SPARK OCCURS WHILE CRANKING ENGINE AND MAKING SPARK CHECK AT SPARK PLUG LEAD, TROUBLE IS NOT IN DISTRIBUTOR |

TASK SHEET GENERAL MOTORS VIII-A-4b(TS)

| | |
|---|---|
| TASK: | COIL TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM - H. E. I. |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, OSCILLOSCOPE - H. E. I., TACH-DWELL METER, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1 ½ VOLT BATTERY, DROPLIGHT, TEST LEADS WITH PROBES, VACUUM TESTER, FENDER COVER, SEAT COVERS, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-A-2(TS) |
| 4. COIL TEST | 1. REMOVE WIRING HARNESS CONNECTOR AND BATTERY LEAD |
| | 2. TURN 4 CAP-TO-HOUSING LATCHES ON DISTRIBUTOR CAP ¼ TURN COUNTER-CLOCKWISE |
| | 3. LIFT OFF DISTRIBUTOR CAP AND COIL ASSEMBLY |
| | 4. TURN CAP AND COIL ASSEMBLY OVER WITH DISTRIBUTOR SPARK PLUG TERMINAL, COIL HIGH-TENSION CARBON BUTTON, AND DISTRIBUTOR CONNECTOR TERMINAL ARE ALL FACING UP |
| | 5. CHECK FOR EVIDENCE OF SPARK ARC-OVER ON ROTOR CAP AND COIL |
| | NOTE: IF EVIDENCE OF ARC-OVER IS FOUND, REPLACE FAULTY COMPONENT |
| | 6. ATTACH ONE OHMMETER LEAD TO BATTERY TERMINAL AS INDEXED ON DISTRIBUTOR CAP |
| | 7. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND |
| | NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL |

| STEPS | KEY POINTS |
|---|---|
| | 8. TURN OHMMETER SCALE TO MIDDLE OR HIGH RANGE |
| | 9. ATTACH ONE OHMMETER LEAD TO TACHOMETER TERMINAL |
| | 10. ATTACH OTHER OHMMETER LEAD TO COIL OUTPUT LEAD (CARBON BUTTON AT CENTER OF DISTRIBUTOR CAP) |
| | 11. OBSERVE OHMMETER READING |
| | NOTE: IF OHMMETER READING IS INFINITE, REPLACE COIL |

| | |
|---|---|
| TASK: | TEST PICK-UP COIL |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM, H. E. I. |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, OSCILLOSCOPE, HEI, TACH-DWELL METER, VOLTMETER, OHMMETER 20,000 OHM/VOLT RATING POWERED BY 1 ½ VOLT BATTERY, DROPLIGHT, TEST LEADS WITH PROBES, VACUUM TESTER, FENDER COVERS, SEAT COVERS, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-B-4(TS) GENERAL MOTORS |
| 4. PICK-UP COIL TEST | 1. DISCONNECT PICK-UP COIL LEADS GOING TO THE MODULE MARKED W & G<br>2. SET OHMMETER FOR MIDDLE SCALE READING<br>3. ATTACH OHMMETER POSITIVE LEAD TO A PICK-UP COIL LEAD<br>4. ATTACH OHMMETER NEGATIVE LEAD TO A GOOD GROUND<br>5. NOTE OHMMETER READING<br>NOTE: OHMMETER SHOULD READ INFINITE AT ALL TIMES. IF READING IS NOT INFINITE REPLACE PICK-UP COIL<br>6. CONNECT VACUUM TESTER TO VACUUM ADVANCE<br>7. ACTIVATE VACUUM UNIT WITH VACUUM TESTER<br>8. OBSERVE OHMMETER READING THROUGHOUT ENTIRE VACUUM RANGE<br>NOTE: OHMMETER READING SHOULD BE INFINITE AT ALL TIMES. IF NOT, REPLACE PICK-UP COIL<br>9. ATTACH ONE OHMMETER LEAD TO ONE WIRE OF PICK-UP COIL |

| STEPS | KEY POINTS |
|---|---|
| | 10. ATTACH OTHER OHMMETER LEAD TO REMAINING WIRE ON PICK-UP COIL |
| | 11. NOTE READING ON OHMMETER SCALE<br>NOTE: IF READING IS LESS THAN 650 OR MORE THAN 850 OHMS AT ANY TIME WHILE ACTIVATING VACUUM ADVANCE UNIT, REPLACE PICK-UP COIL. IF NO FAULT HAS BEEN FOUND AT THIS POINT, REPLACE MODULE AND IF THE CONDITION STILL EXISTS, CHECK PICK-UP COIL MAGNET |

TASK SHEET GENERAL MOTORS VIII-A-4d(TS)

TASK: TEST PICK-UP COIL MAGNETISM

JOB: TEST ELECTRONIC IGNITION SYSTEM H. E. I.

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, DROPLIGHT, FENDER COVERS, SEAT COVERS, FERROUS FEELER GAUGE OR LIGHT STEEL STRIP OF METAL, CLEAN RAG

TASK BREAKDOWN:

| STEPS | KEYPOINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-A-2(TS) GENERAL MOTORS<br>VIII-A-2b(TS) GENERAL MOTORS |
| 4. TEST PICK-UP COIL MAGNETISM | 1. TURN KEY OFF<br>2. CLEAN PICK-UP COIL MAGNET WITH CLEAN RAG<br>3. TOUCH POLE OF MAGNET WITH METAL FEELER GAUGE BLADE<br>NOTE: MAGNETISM AT THIS POINT SHOULD BE STRONG ENOUGH TO HOLD BLADE TIGHTLY IN PLACE. IF NOT, REPLACE MAGNET<br>4. DISCONNECT ANY TEST EQUIPMENT<br>CAUTION: CHECK GENERAL MOTOR'S HOOKUP RECOMMENDATIONS BEFORE ATTACHING ANY TEST INSTRUMENT TO H. E. I. SYSTEM |

VIII-A-5(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | TEST STORAGE BATTERY |
| AIM: | 1. THE STUDENT WILL BE ABLE TO PREPARE AND ADJUST BATTERY TESTING EQUIPMENT IN PREPARATION FOR TESTING STORAGE BATTERY CONDITION<br>2. THE STUDENT WILL BE ABLE TO MAKE NECESSARY STORAGE BATTERY TESTS TO DETERMINE BATTERY CONDITION<br>3. THE STUDENT WILL BE ABLE TO INTERPRET STORAGE BATTERY TEST RESULTS AND MAKE JUDGMENTS AND DECISIONS CONCERNING NECESSARY STEPS TO TAKE IN BATTERY SERVICE OR REPLACEMENT |
| TOOLS AND EQUIPMENT: | HYDROMETER, BATTERY STARTER TESTER, BATTERY CHARGER |
| MATERIALS: | BATTERY WATER, CLEAN RAGS |
| TEACHING AIDS: | MANUFACTURER'S SPECIFICATIONS, HYDROMETER CONVERSION TABLE |
| REFERENCES: | AUTOMECHANICS, CH. 18<br>AUTO SERVICE AND REPAIR, CH. 22<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450<br>AUTOMOTIVE MECHANICS, CHS. 13, 23 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE PERFORMED THE TASK OF SERVICING THE STORAGE BATTERY AND MADE PRELIMINARY PREPARATIONS BY STUDYING THE RECOMMENDED REFERENCES. |
| CHECKING STANDARDS: | 1. MAINTAIN SAFE WORKING HABITS.<br>2. SELECTION OF PROPER TOOLS AND EQUIPMENT.<br>3. MAINTAIN CRAFTSMANLIKE PROCEDURES FOR PERFORMING TASKS.<br>4. HAVE AN APPRECIATION FOR TOOLS AND EQUIPMENT AND CUSTOMER'S VEHICLE. |

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## I. PREPARATION (OF THE LEARNER)

THERE ARE NINE APPARENT REASONS WHY A BATTERY WILL GO BAD OR NEED IMMEDIATE ATTENTION: INSUFFICIENT ELECTROLYTE, MECHANICAL DAMAGE, OVERHEATING, OVERCHARGING, BUCKLED PLATES, FREEZING, VIBRATION, CORROSION, AND BATTERY REJUVENATORS, OTHERWISE KNOWN AS "DAPES".

## I. PREPARATION (CON'T)

THE MECHANIC MUST POSSESS A FULL KNOWLEDGE OF THE STORAGE BATTERY. NO DIAGNOSIS OF THE AUTOMOBILE ENGINE AND ITS ACCESSORIES CAN BE COMPLETE WITHOUT FIRST ANALYZING THE BATTERY CONDITION. A BATTERY TO BE FULLY SERVICEABLE MUST BE FULLY CHARGED.

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## II. PRESENTATION (OF THE MATERIAL)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. VISUAL INSPECTION | 1. BATTERY CABLES<br>a. INSULATION IN GOOD CONDITION<br>b. TERMINALS NOT DEFORMED, BROKEN, OR CORRODED BADLY<br>2. BATTERY<br>a. CASE NOT CRACKED OR WORN THROUGH FROM VIBRATION<br>b. TERMINALS NOT DEFORMED, BROKEN, CORRODED, OR LOOSE IN THE CASE<br>3. BATTERY BOX AND THE HOLD DOWN IN GOOD CONDITION |
| 2. ANALYZE ELECTROLYTE | 1. WEAR GOGGLES<br>2. REMOVE BATTERY CAPS<br>3. SQUEEZE BULB OF HYDROMETER<br>4. INSERT RUBBER TIP END IN CELL<br>5. RELEASE BULB, ALLOW SOME ELECTROLYTE TO ENTER BARREL<br>a. GOOD ELECTROLYTE IS CLEAN AND CLEAR<br>b. BROWN OR REDDISH ELECTROLYTE INDICATES POSITIVE PLATE TROUBLES<br>(1) WORN OUT FROM LACK OF WATER<br>(2) FREEZING<br>(3) SHORT CIRCUIT<br>c. MILKY WHITE ELECTROLYTE<br>(1) MADE BY SMALL AIR BUBBLES<br>(2) GENERATOR IS OVERCHARGING BATTERY<br>d. BLACK SPECKS OR TRASH IN ELECTROLYTE<br>(1) WOOD SEPARATORS HAVE BEEN CHARRED |

(2) RESULTS OF OVER CHARGE OR

6. REPEAT OPERATION FOR ALL CELLS (3 OR 6)

3. PERFORM HYDROMETER TEST

1. SQUEEZE HYDROMETER BULB
2. INSERT RUBBER TIP IN BATTERY CELL OPENING
3. RELEASE BULB WITH HYDROMETER HELD VERTICALLY
4. ALLOW LIQUID TO FLOW INTO BARREL
5. THE FLOAT WILL RISE
6. HOLD TOP OF LIQUID IN HYDROMETER BARREL LEVEL WITH EYES
7. TAKE READING ON FLOAT AT BOTTOM OF LIQUID CURVE
8. IF HYDROMETER HAS THERMOMETER CHECK TEMPERATURE AND CONSULT CONVERSION TABLE TO ADD OR SUBTRACT POINTS FROM FLOAT READING
9. RECORD READING
10. REPEAT KEY POINTS 1 THROUGH 9 FOR ALL CELLS

NOTE: IF ANY ONE CELL IS IN EXCESS OF 15 POINTS LOWER THAN THE OTHER CELLS, IT COULD BE SHORTED OR SHORT ON ELECTROLYTE

a. SERVICE THE CELL
b. CHARGE BATTERY
c. IF CELL DOES NOT COME UP TO OTHERS OR COMES UP FOR SHORT TIME THE CELL IS DEFECTIVE. BATTERY MUST BE REPLACED

BE SURE TO CHECK TEMPERATURES FOR ALL READINGS ON HYDROMETER, IF THERMOMETER IS NOT ON HYDROMETER CHECK TEMPERATURE OF ELECTROLYTE WITH THERMOMETER. USE CONVERSION CHART TO FIND POINTS TO ADD TO OR SUBTRACT FROM THE HYDROMETER READING

4. LOAD TEST BATTERY

1. COMPLETE INFORMATION ABOUT THE BATTERY CONDITION AND CAPACITY CAN BE OBTAINED ONLY BY MAKING

AN ELECTRICAL TEST

2. CAPACITY TEST IS NOT TO BE ATTEMPTED IF ELECTROLYTE SPECIFIC GRAVITY IS LOWER THAN 1.220
3. IF SPECIFIC GRAVITY IS BELOW 1.220 SLOW CHARGE BATTERY UNTIL FULLY CHARGED
4. USE BATTERY STARTER TESTER
    a. ATTACH TESTER TO BATTERY ACCORDING TO MANUFACTURER'S SPECIFICATIONS
    b. CARBON PILE LOAD TEST SWITCH TO BE IN OFF POSITION
    c. CONNECT BOTH POSITIVE LEADS TO POSITIVE POST
    d. CONNECT BOTH NEGATIVE LEADS TO NEGATIVE POST
5. CHECK BATTERY FOR AMP HOUR RATING
6. ADJUST CARBON PILE LOAD SWITCH TO PLACE A LOAD OF THREE TIMES THE AMPERE HOUR RATING ON THE BATTERY
7. MAINTAIN LOAD ON BATTERY FOR FIFTEEN SECONDS
    a. 12 VOLT BATTERY MIANTAINS 9.5 VOLTS AFTER LOAD
    b. 6 VOLT BATTERY MAINTAINS 4.8 VOLTS AFTER LOAD
8. IF BATTERY DOES NOT MAINTAIN 9.5 VOLTS OR 4.8 VOLTS AFTER TEST, PERFORM THREE MINUTE CHARGE TEST

5. THREE MINUTE CHARGE TEST

1. BATTERY TEMPERATURE TO BE ABOVE 60 DEGREES FAREHEIGHT
2. BATTERY CABLES ARE TO BE REMOVED FROM BATTERY
3. BATTERY CHARGER SWITCH IS TO BE IN OFF POSITION
4. PLUG BATTERY CHARGER INTO POWER SOURCE
5. CONNECT POSITIVE LEAD OF BATTERY CHARGER TO POSITIVE POST OF BATTERY

6. CONNECT NEGATIVE LEAD OF BATTERY CHARGER TO NEGATIVE POST OF BATTERY
7. HOOK VOLT METER TO BATTERY POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE
8. SET BATTERY CHARGER TIMER
   a. ON THREE MINUTES
   b. TURN TIMER PAST THREE MINUTES
9. ADJUST CHARGING RATE
   a. 40 AMPS FOR 12 VOLT BATTERY
   b. 75 AMPS FOR 6 VOLT BATTERY
10. TURN ON BATTERY CHARGER AND ALLOW TO CHARGE UNTIL TIMER STOPS CHARGING RATE
11. CHARGER TO REMAIN ON
12. CHECK VOLT METER READING
    a. READING IN EXCESS OF 15.5 VOLTS FOR 12 VOLT BATTERY OR 7.75 VOLTS FOR 6 VOLT BATTERY, REPLACE BATTERY
    b. READING UNDER 15.5 OR 7.75, CHECK INDIVIDUAL CELLS
    c. CELL VOLTAGES DIFFER MORE THAN .01 VOLT REPLACE BATTERY
    d. CELL VOLTAGES DIFFER LESS THAN .01 VOLT, CHARGE BATTERY AND PLACE IN SERVICE

6. LIGHT LOAD BATTERY TEST

1. USE VOLT METER
2. CRANK ENGINE FOR THREE SECONDS;
3. TURN LIGHTS ON
   a. LOW BEAM
   b. ALLOW TO BURN FOR ONE MINUTE
   c. LEAVE LIGHTS ON
4. OIL IS TO RUN DOWN BOLT AND COVER NUT
5. WIPE OFF EXCESS OIL WITH RAG

7. TEST BATTERY FOR OPERATION

1. CLEAR ALL TOOLS AND MATERIALS FROM ENGINE COMPARTMENT
2. CLEAN HANDS
3. PLACE COVER OVER VEHICLE SEAT
4. CHECK SHOES, WIPE SOLES CLEAN BEFORE ENTERING VEHICLE

| | |
|---|---|
| | 5. TURN ON IGNITION<br>6. START VEHICLE<br>7. IF STARTER DOES NOT TURN ENGINE OVER, OR TURNS SLOWLY:<br>a. CHECK BATTERY CONNECTIONS<br>b. MAY BE NECESSARY TO CHANGE BATTERY |
| 8. CLEAN WORK STATION | 1. AS HAS BEEN PERFORMED IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

STUDENTS TO BE FURNISHED WITH JOB AND TASK SHEETS.

STUDENTS TO PRACTICE TASK UNDER CLOSE SUPERVISION.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

EMPHASIS PLACED ON SAFETY.
JEWELRY AND WORKING WITH ELECTRICITY.
WORKING WITH ACID.
WEARING OF FACE SHIELDS OR GOGGLES.
PICKING UP OF HEAVY OBJECTS.
REEMPHASIZE KEY POINTS OF LESSON.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 8
AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CHS. 13, 23

THE NEXT LESSON IS: VIII-A-6(S) "TEST CRANKING SYSTEM"

## JOB SHEET
## IN
## ELECTRICAL SYSTEM

**JOB:** TEST STORAGE BATTERY

**MATERIALS:** BATTERY WATER, ELECTROLYTE, CLEAN RAGS

**TOOLS AND EQUIPMENT:** HYDROMETER, THERMOMETER, SPECIFIC GRAVITY CONVERSION CHART, BATTERY STARTER TESTER, BATTERY CHARGER

**GENERAL INSTRUCTIONS:** BATTERY EFFICIENCY DEPENDS UPON THE LEVEL OF CHARGE AND TEMPERATURE. CHARGE IS DEPENDENT ON THE MECHANICAL CONDITION OF THE BATTERY. PARTS OF THE BATTERY MUST BE IN A STATE OF GOOD REPAIR. BATTERIES ARE NOT TO BE CAPACITY TESTED IF THE SPECIFIC GRAVITY READING IS BELOW 1.220. IN THE EVENT THE SPECIFIC GRAVITY READING IS BELOW 1.220 IT WILL BE NECESSARY TO SLOW CHARGE THE BATTERY TO FULL CHARGE BEFORE THE CAPACITY TEST IS MADE. SAFETY AND CLEANLINESS ARE MUSTS WHEN WORKING WITH STORAGE BATTERIES.

WEAR GOGGLES OR FACE SHIELD WHEN WORKING WITH BATTERIES. REMOVE WATCHES AND RINGS BECAUSE BURNS CAN RESULT FROM ELECTRICAL SHORTS. ELECTROLYTE IS TO BE KEPT OFF PERSON AND CLOTHING. EXERCISE CAUTION NOT TO SHORT OUT BATTERY AS THE GASES GIVEN OFF BY THE ELECTROLYTE ARE EXPLOSIVE.

**PROCEDURE:**

| | |
|---|---|
| VIII-A-5(TS) | VISUALLY INSPECT BATTERY |
| VIII-A-5a(TS) | TEST ELECTROLYTE |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR PROPER RESULTS AND FURTHER INSTRUCTION BEFORE PROCEEDING TO NEXT TASK.

| | |
|---|---|
| VIII-A-5b(TS) | LOAD TEST BATTERY |
| VIII-A-5c(TS) | THREE MINUTE CHARGE TEST BATTERY |
| VIII-A-5d(TS) | LIGHT LOAD TEST BATTERY |

## TASK SHEET

VIII-A-5(TS)

TASK: VISUALLY INSPECT BATTERY

JOB: SERVICE STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS:

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. BATTERY CASE | 1. CRACKS<br>a. CAN BE CRACKED FROM EXPANSION OF LARGE CRYSTAL SULPHATE ON PLATES<br>b. CAN BE CRACKED FROM FREEZING<br>c. CAN BE CRACKED FROM MECHANICAL DAMAGE<br>2. WEAR THROUGH FROM VIBRATION |
| 2. POST STRAP | 1. WORN THROUGH<br>2. PARTIALLY WORN THROUGH<br>3. MECHANICAL DAMAGE |
| 3. POST | 1. CORRODED<br>2. PITTED<br>3. LOOSE<br>4. DEFORMED<br>5. BROKEN |
| 4. CABLES | 1. INSULATION<br>2. DEFORMED<br>3. BROKEN<br>4. LOOSE<br>5. CORRODED |

## TASK SHEET VIII-A-5a(TS)

TASK: TEST ELECTROLYTE

JOB: TEST STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HYDROMETER, CLEAN RAGS, THERMOMETER, ELECTROLYTE, TEMPERATURE CONVERSION TABLE. (HYDROMETER MAY COME EQUIPPED WITH CONVERSION TABLE AND THERMOMETER)

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. NOTE | 1. IF ANY ONE CELL IS IN EXCESS OF 15 POINTS LOWER THAN OTHER CELLS IT COULD BE SHORTED OR LOW ON ELECTROLYTE<br>a. BATTERY MUST BE SERVICED<br>b. BATTERY MUST BE CHARGED<br>c. IF CELL DOES NOT COME UP TO OTHERS OR COMES UP ONLY FOR A SHORT TIME AFTER SERVICE AND CHARGE, BATTERY MUST BE REPLACED<br>2. BE SURE TO CHECK TEMPERATURES FOR ALL READINGS ON HYDROMETER<br>3. IF THERMOMETER IS NOT ON HYDROMETER, USE NON-METALLIC GLASS THERMOMETER TO GET TEMPERATURE<br>4. USE ELECTROLYTE TEMPERATURE CONVERSION CHART TO DETERMINE NUMBER OF POINTS TO ADD TO OR SUBTRACT FROM THE HYDROMETER READING |
| 2. PREPARE BATTERY | 1. IF BATTERY HAS NOT BEEN CLEANED BRUSH OFF TOP OF BATTERY BEING SURE NO FOREIGN MATTER WILL FALL INTO CELLS<br>2. REMOVE CAPS FROM CELLS |
| 3. TAKE CELL READINGS | 1. EACH READING IS TO BE RECORDED<br>2. USE HYDROMETER<br>3. HOLD HYDROMETER VERTICAL WITH BULB UP |

| STEPS | KEY POINTS |
|---|---|
| | 4. SQUEEZE HYDROMETER BULB WITH ONE HAND FORCING AIR OUT |
| | 5. INSERT HYDROMETER TIP INTO ELECTROLYTE IN FIRST CELL ON POSITIVE POST SIDE OF BATTERY |
| | 6. RELEASE GRIP ON BULB<br>a. DRAW ELECTROLYTE INTO HYDROMETER<br>b. ALLOW TO STAND A FEW SECONDS<br>c. SQUEEZE BULB AND FORCE ELECTROLYTE BACK INTO BATTERY<br>d. REPEAT THIS PROCEDURE UNTIL THE THERMOMETER HAS REACHED BATTERY TEMPERATURE<br>e. RECORD BATTERY TEMPERATURE |
| | 7. RELEASE GRIP ON BULB AND SLOWLY ALLOW ELECTROLYTE TO FLOW INTO HYDROMETER |
| | 8. WHEN THE FLOAT RISES STOP PULLING THE ELECTROLYTE INTO HYDROMETER, FLOAT MUST CLEAR BOTTOM OF HYDROMETER |
| | 9. CONTINUE TO HOLD THE BULB AT THIS POINT. DO NOT SQUEEZE OR RELAX GRIP |
| | 10. GENTLY TAP TIP ON SIDE OF THE CELL OPENING TO KNOCK OFF EXCESS ELECTROLYTE |
| | 11. RAISE HYDROMETER OUT OF CELL |
| | 12. PLACE FOLDED RAG UNDER TIP WITH OTHER HAND |
| | 13. RAISE (MONISCUS) CURVED TOP LEVEL OF LIQUID TO EYE LEVEL |
| | 14. HOLD HYDROMETER IN SUCH A MANNER AS TO ALLOW LIGHT TO SHOW THROUGH IN ORDER TO TAKE READING |
| | 15. TAKE READING AT BOTTOM OF CURVED LIQUID (MONISCUS) |
| | 16. LOWER TIP OF HYDROMETER BACK TO TOP OF CELL<br>a. FROM WHICH ELECTROLYTE WAS REMOVED<br>b. REMOVE RAG |

| STEPS | KEY POINTS |
|---|---|
| | c. INSERT TIP OF HYDROMETER IN CELL |
| | 17. GENTLY SQUEEZE BULB AND FORCE ELECTROLYTE BACK INTO CELL, MAKE SURE ALL ELECTROLYTE IS OUT OF HYDROMETER |
| | 18. RECORD READING WITH TEMPERATURE READING |
| | 19. REPEAT KEY POINTS 1 THROUGH 17 FOR ALL CELLS MOVING FROM POSITIVE SIDE OF BATTERY TO NEGATIVE SIDE OF BATTERY |
| | 20. PUT CAPS BACK ON BATTERY CELLS |
| 4. CLEAN HYDROMETER | 1. USE CLEAN WATER |
| | 2. DRAW WATER INTO HYDROMETER |
| | 3. SQUEEZE WATER OUT INTO DRAIN |
| | 4. REPEAT THIS PROCEDURE SEVERAL TIMES |
| | 5. RUN WATER OVER OUTSIDE OF HYDROMETER |
| | 6. DRY HYDROMETER ON OUTSIDE THOROUGHLY |
| | 7. STORE HYDROMETER |
| 5. DETERMINE BATTERY CONDITION | 1. COMBINE EACH CELL READING WITH TEMPERATURE |
| | 2. COMPARE EACH CELL READING AND TEMPERATURE WITH THE CONVERSION CHARTS |
| | 3. ADD TO OR SUBTRACT FROM EACH CELL READING POINTS AND SPECIFIED BY CONVERSION CHART |
| | 4. RECORD NEW READINGS |
| | 5. MAKE DECISION<br>a. TO SERVICE BATTERY<br>b. TO CHARGE BATTERY<br>c. BATTERY IS TO REMAIN IN SERVICE<br>d. BATTERY IS TO BE REPLACED |
| 6. CHECK POINT | CHECK WITH INSTRUCTOR FOR PROPER RESULTS OR FURTHER INSTRUCTIONS BEFORE PROCEEDING |
| 7. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-A-5b(TS)

TASK: LOAD TEST BATTERY

JOB: TEST STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HYDROMETER, BATTERY STARTER TESTER, BATTERY CHARGER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK BATTERY | 1. MECHANICALLY SOUND<br>2. ELECTROLYTE AT PROPER LEVEL IN BATTERY<br>3. USE HYDROMETER TO CHECK SPECIFIC GRAVITY<br>a. AS IN TASK VIII-A-5a(TS)<br>b. SPECIFIC GRAVITY IS NOT BE TO BELOW 1.220<br>c. IF SPECIFIC GRAVITY IS BELOW 1.220 SLOW CHARGE BATTERY UNTIL IT IS FULLY CHARGED |
| 2. CONNECT BATTERY STARTER TESTER | 1. CONNECT TESTER TO BATTERY ACCORDING TO MANUFACTURER'S SPECIFICATIONS<br>2. LOAD TEST SWITCH IS TO BE IN OFF POSITION<br>3. CONNECT TESTER LEADS TO BATTERY<br>a. CONNECT BOTH TESTER POSITIVE LEADS TO POSITIVE POST<br>b. CONNECT BOTH TESTER NEGATIVE LEADS TO NEGATIVE POST<br>4. CHECK LEGEND ON BATTERY OR MANUFACTURER'S MANUAL FOR BATTERY AMP HOUR RATING<br>5. MULTIPLY THE BATTERY AMP HOUR RATING BY THREE |
| 3. TEST BATTERY | 1. TURN ON (CARBON PILE SWITCH) LOAD SWITCH<br>2. ADJUST THE LOAD SWITCH TO NUMBER FOUND BY MULTIPLYING THE BATTERY AMP HOUR RATING BY THREE |

| STEPS | KEY POINTS |
|---|---|
| | 3. MAINTAIN LOAD ON BATTERY FOR 15 SECONDS<br>a. 12 VOLT BATTERY IS TO MAINTAIN 9.5 VOLTS AFTER 15 SECOND LOAD<br>b. 6 VOLT BATTERY IS TO MAINTAIN 4.8 VOLTS AFTER 15 SECOND LOAD<br>4. TURN OFF TESTER AFTER 15 SECONDS<br>5. IF BATTERY DOES NOT MAINTAIN 9.5 VOLTS FOR 12 VOLT BATTERIES OR 4.8 VOLTS FOR 6 VOLT BATTERIES AFTER LOAD TEST, PERFORM 3 MINUTE TEST AS IN TASK VIII-A-5c(TS) |
| 4. DISCONNECT TESTER | 1. NEGATIVE LEADS FIRST<br>2. POSITIVE LEADS LAST<br>3. NEATLY LOOP TESTER LEADS OVER BRACKETS ON TESTER<br>4. STORE TESTER |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-A-5c(TS)

TASK: THREE MINUTE CHARGE TEST BATTERY

JOB: TEST STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLT METER, BATTERY CHARGER, BATTERY TERMINAL TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK BATTERY TEMPERATURE | 1. REMOVE BATTERY CABLES, NEGATIVE LEAD FIRST<br>2. USE GLASS TYPE THERMOMETER OR HYDROMETER AS IN TASK VIII-A-5a(TS)<br>3. BATTERY TEMPERATURE MUST BE ABOVE 60 DEGREES F. |
| 2. CONNECT BATTERY CHARGER | 1. CHARGER SWITCH IS TO BE IN OFF POSITION<br>2. CONNECT CHARGER LEADS TO BATTERY<br>a. POSITIVE TO POSITIVE POST FIRST<br>b. NEGATIVE TO NEGATIVE POST SECOND<br>3. PLUG CHARGER INTO POWER SOURCE |
| 3. CONNECT VOLT METER | 1. TO BATTERY<br>2. POSITIVE LEAD TO POSITIVE POST FIRST<br>3. NEGATIVE LEAD TO NEGATIVE POST LAST |
| 4. CHARGE BATTERY | 1. SET CHARGER TIMER<br>a. 3 MINUTES<br>b. TURN TIMER PAST 3 MINUTES AND CAREFULLY BACK TO 3 MINUTES<br>2. ADJUST CHARGER CHARGING RATE<br>a. 40 AMPS FOR 12 VOLT BATTERY<br>b. 75 AMPS FOR 6 VOLT BATTERY<br>3. TURN ON CHARGER AND ALLOW TO CHARGE UNTIL TIMER STOPS CHARGING RATE |
| 5. CHECK VOLT METER READING | 1. CHARGER TO REMAIN ON<br>2. READING IN EXCESS OF 15.5 VOLTS FOR 12 VOLT BATTERY OR 7.75 VOLTS |

| STEPS | KEY POINTS |
|---|---|
| | FOR 6 VOLT BATTERY, REPLACE BATTERY<br>3. READINGS OF UNDER 15.5 OR 7.75 INDIVIDUAL CELLS MUST BE CHECKED<br>4. CELL VOLTAGES DIFFERENCES OF MORE THAN .01 VOLT, BATTERY IS TO BE REPLACED<br>5. CELL VOLTAGE DIFFERENCE OF LESS THAN .01 VOLT, CHARGE BATTERY AND PLACE IN SERVICE |
| 6. DISCONNECT EQUIPMENT | 1. TURN OFF CHARGER<br>2. VOLT METER NEGATIVE LEAD FIRST AND THEN POSITIVE LEAD<br>3. ROLL UP THE VOLT METER LEADS AND PLACE VOLT METER IN STORAGE<br>4. DISCONNECT CHARGER NEGATIVE LEAD FIRST AND THEN POSITIVE LEAD<br>5. ROLL UP LEADS AND HANG ON CHARGER BRACKETS<br>6. STORE BATTERY CHARGER<br>7. CONNECT BATTERY LEADS POSITIVE FIRST AND THEN NEGATIVE |
| 7. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-A-5d(TS)

TASK: LIGHT LOAD TEST BATTERY

JOB: TEST STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLT METER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE BATTERY FOR TEST | 1. CRANK ENGINE FOR 3 SECONDS<br>2. ENGINE IS NOT TO START<br>3. TURN LIGHTS ON<br>a. ON LOW BEAM<br>b. ALLOW LIGHTS TO BURN 1 MINUTE<br>c. LEAVE LIGHTS ON |
| 2. MAKE BATTERY TEST | 1. USE VOLT METER<br>2. PLACE VOLT METER PROBES ON BATTERY POSTS<br>3. BATTERY VOLTAGE READING IS TO BE 11.70 OR BETTER<br>4. LOW READING<br>a. TURN LIGHTS OFF<br>b. REMOVE BATTERY CABLES<br>c. SLOW CHARGE BATTERY UNTIL FULLY CHARGED<br>d. DISCONNECT BATTERY CHARGER<br>e. REPLACE BATTERY CABLES<br>f. REPEAT STEP 1 AND KEY POINTS 1, 2, 3, OF STEP 2 |
| 3. TEST CELLS | 1. BATTERIES WITH EXPOSED CELL STRAPS<br>2. STEP ONE APPLIES HERE<br>3. PROBE EACH CELL WITH VOLT METER<br>a. POSITIVE POST TO END OF STRAP IN SAME CELL<br>b. END OF STRAP TOWARDS POSITIVE POST IN EACH CELL IS POSITIVE SIDE<br>4. EACH CELL IS TO HAVE A VOLTAGE READING OF 1.95 OR MORE<br>5. IF THERE IS NO MORE THAN .05 VOLT DEVIATION BETWEEN BATTERY CELLS, BATTERY IS GOOD |

| STEPS | KEY POINTS |
|---|---|
|  | 6. IF THE CELL DEVIATION IS MORE THAN .05 VOLT THE PROBABLE INDICATION IS THAT THE BATTERY IS DEFECTIVE |
|  | 7. LOW CELL READINGS ALL ACROSS, THE BATTERY NEEDS CHARGING AND RETESTING |
| 4. CLEAN WORK STATION | AS IN PRECEDING TASKS |

VIII-A-6(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** TEST AUTOMOBILE CRANKING SYSTEM

**AIMS:**

1. THE STUDENT WILL BE ABLE TO TEST FOR AND DIAGNOSE AUTOMOBILE ENGINE CRANKING SYSTEM TROUBLES.
2. THE STUDENT WILL BE ABLE TO UTILIZE AND ADJUST AUTOMOBILE CRANKING SYSTEM TEST EQUIPMENT IN ORDER TO DIAGNOSE AUTOMOBILE CRANKING SYSTEMS.
3. THE STUDENT WILL BE ABLE TO MAKE JUDGMENTS AND DECISIONS CONCERNING THE OVERHAUL, SERVICE, OR MAINTENANCE OF THE AUTOMOBILE CRANKING SYSTEM.

**TOOLS AND EQUIPMENT:** BATTERY TEST EQUIPMENT, STARTER TEST EQUIPMENT

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** TRANSPARENCIES, FIGS, 202-206

**REFERENCES:**

AUTOMECHANICS, CH. 9
AUTOMOTIVE ENCYCLOPEDIA, PP. 371-385
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CH. 23

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE COMPLETED THE RELATED LESSON ON BASIC ELECTRICITY, STUDIED THE REFERENCE MATERIAL, AND PERFORMED THE JOB OF "TEST THE STORAGE BATTERY"

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. PRACTICE SAFE WORKING HABITS
3. PROPERLY ADJUST AND USE TEST EQUIPMENT
4. APPRECIATION FOR TEST EQUIPMENT AND CUSTOMER'S VEHICLE
5. COOPERATION WITH INSTRUCTOR AND CO-WORKER
6. CRAFTSMANLIKE PERFORMANCE OF JOB AND ADHERENCE TO STANDARDS SET BY MANUFACTURERS FOR SPECIFICATIONS

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## I. PREPARATION (OF THE LEARNER)

AT ONE TIME VEHICLE ENGINES WERE STARTED WITH A HAND CRANK, WHICH RESULTED IN MANY BROKEN ARMS, SPRAINED WRISTS AND ELBOWS, AS WELL AS DAMAGED RADIATORS FROM FLYING CRANKS.

IN ORDER FOR THE MANUFACTURER TO SELL VEHICLES TO THE FEMALE

POPULATION SOME EASIER MEANS OF STARTING AN ENGINE BECAME NECESSARY.

AT THE OUTSET THE STARTER BUTTON WAS IN THE FLOORBOARD CLOSE TO THE FRONT SEAT AND THE OPERATOR STAMPED ON IT WITH THE HEEL OF THE FOOT. PROGRESSIVELY THE STARTER SWITCH HAS MOVED AROUND FROM PLACE TO PLACE ON THE FLOORBOARD, DASH, AND FINALLY TO THE IGNITION KEY.

TODAY THE CRANK SOCKET REMAINS ON THE FRONT OF THE CRANKSHAFT, BUT THERE IS NO ACCESS HOLE IN THE BUMPER OR GRILL. NEITHER DOES A CRANK COME WITH THE AUTOMOBILE AS AN ACCESSORY.

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. TEST THE STORAGE BATTERY | 1. FOR PROPER OPERATION<br>2. AS IN JOB VIII-A-5(J) |
| 2. CHECK TERMINALS | 1. CORROSION<br>2. TIGHT<br>3. BROKEN WIRES |
| 3. TEST GROUND CIRCUIT | 1. FOR VOLTAGE LOSS<br>2. BETWEEN GROUNDED BATTERY TERMINAL AND VEHICLE FRAME OR ENGINE BLOCK<br>3. USE VOLTMETER<br>4. REMOVE IGNITION WIRE FROM COIL POST TO PREVENT ENGINE STARTING<br>5. CONNECT VOLTMETER TO NEGATIVE POST OF BATTERY AND TO GROUND POINT<br>6. CRANK ENGINE OVER AND OBSERVE VOLTAGE READING. VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT<br>NOTE: STARTER IS NOT TO BE RUN IN EXCESS OF 30 SECONDS AT ANY ONE TIME<br>7. EXCESSIVE VOLTAGE DROP IS CAUSED BY BAD CONNECTION, STARTER, BATTERY, CABLE, GROUND |
| 4. TEST BETWEEN GROUND AND STARTER FIELD FRAME | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER |

3. ATTACH VOLTMETER TO THE VEHICLE FRAME OR ENGINE BLOCK DEPENDING ON BATTERY GROUND TERMINAL
4. ATTACH VOLTMETER TO THE STARTER FIELD FRAME
5. CRANK ENGINE OVER AND OBSERVE VOLTMETER READING
6. VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT
7. EXCESSIVE VOLTAGE DROP, BAD CONNECTION

5. TEST INSULATED CIRCUIT
   1. FOR VOLTAGE LOSS
   2. USE VOLTMETER
   3. ATTACH VOLTMETER TO THE BATTERY TERMINAL POST
   4. ATTACH VOLTMETER TO STARTING MOTOR TERMINAL STUD (SOLENOID EQUIPPED, USE BATTERY TERMINAL STUD ON SOLENOID)
   5. CRANK ENGINE OVER AND OBSERVE VOLTMETER READING
   6. VOLTAGE DROP SHOULD NOT BE MORE THAN .01 VOLT FOR NORMAL LENGTH, SHORT, INSULATED LEAD

      NOTE: IF EXCESSIVELY LONG INSULATED LEAD IS USED

      a. CHECK SEVERAL OTHER VEHICLES WITH SAME HOOK UP TO DETERMINE RESISTANCE
      b. USE NEW INSULATED CABLE TO CHECK RESISTANCE AND DROP
      c. CALCULATE RESISTANCE FOR INSULATED LEAD ON VEHICLE

   7. EXCESSIVE VOLTAGE DROP BAD CONNECTIONS, BATTERY, STARTER, CABLE, GROUND

6. TEST SAFETY LOCK OUT SWITCH
   1. AUTOMATIC TRANSMISSIONS
   2. FOR PROPER ADJUSTMENT, ACCORDING TO MANUFACTURER'S SPECIFICATIONS
   3. FOR MECHANICAL FAILURE

7. LOAD TEST STARTER
   1. AMPERAGE DRAW TEST ON VEHICLE

2. TO DETERMINE WHETHER OR NOT STARTING MOTOR MUST BE REMOVED FOR STALL AND NO-LOAD TEST
3. ENGINE TO BE STARTED AND RUN UNTIL NORMAL OPERATING TEMPERATURE IS OBTAINED
4. STOP ENGINE
5. REMOVE PRIMARY LEAD FROM IGNITION COIL
6. CONNECT TEST EQUIPMENT
    a. TO BATTERY
    b. LARGE LEADS
        (1) RED TO POSITIVE POST
        (2) BLACK TO NEGATIVE POST
    c. SMALL LEADS
        (1) DRIVE ICE PICK INTO EACH BATTERY POST
        (2) CONNECT RED LEAD TO PICK IN POSITIVE
        (3) CONNECT BLACK TO PICK IN NEGATIVE POST
7. CONNECT REMOTE STARTER JUMPER TO STARTER RELAY SWITCH
    a. RED LEAD BATTERY TERMINAL
    b. BLACK LEAD ON STARTER TERMINAL ACCORDING TO TYPE RELAY
8. ADJUST VARIABLE RESISTANCE OF TESTER TO MAXIMUM

    NOTE: THIS IS TO PREVENT CURRENT FROM FLOWING THROUGH AMMETER

9. CRANK ENGINE FOR 15 SECONDS
10. NOTE EXACT READING ON VOLTMETER
11. STOP CRANKING ENGINE
12. ADJUST VARIABLE RESISTANCE OF THE TESTER TO READ SAME VOLTAGES AS WHEN CRANKING ENGINE
13. CRANK ENGINE
14. NOTE AMPERAGE DRAW

    NOTE: THIS AMPERAGE DRAW IS AMPERAGE USED BY STARTER UNDER LAOD

15. COMPARE AMPERAGE DRAW NOTED IN KEY POINT 14 WITH MANUFACTURER'S SPECIFICATIONS

| | |
|---|---|
| | NOTE: USUALLY AMPERAGE DRAW IS FROM 150 AMPS. TO 200 AMPS. |
| 8. CLEAN WORK STATION | 1. REMOVE THE TEST EQUIPMENT FROM CRANKING SYSTEM<br>2. REPLACE PRIMARY LEAD ON IGNITION COIL<br>3. CLEAN WORK STATION AS IN PREVIOUS TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. CHECK STUDENTS FOR KEY POINTS
2. STUDENTS TO PRACTICE JOB UNDER CLOSE SUPERVISION

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

USE PERFORMANCE TEST, PUT STUDENTS ON THEIR OWN TO PERFORM THE TASKS OF THEIR JOB.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT STEPS FROM STAGE II AND EMPHASIZE NEED FOR FOLLOWING TEST PROCEDURE.
2. REEMPHASIZE NEED FOR SAFETY AND SAFETY FACTORS.
3. COVER PERTINENT KEY POINTS.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 8
AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CHS. 13, 23

THE NEXT LESSON IS: VIII-A-7(S) "TEST D.C. TYPE CHARGING SYSTEM"

VIII-A-6(J)

# JOB SHEET
# IN
# CRANKING SYSTEM

**JOB:** TEST AUTOMOTIVE CRANKING SYSTEM

**MATERIALS:**

**TOOLS AND EQUIPMENT:** BATTERY-STARTER TESTER, 2 ICE PICKS, BATTERY TERMINAL TOOLS, REMOTE STARTER JUMPER

**GENERAL INSTRUCTIONS:** ELECTRIC STARTING MOTORS ARE DESIGNED PRINCIPALLY FOR THE PURPOSE OF ROTATING INTERNAL COMBUSTION OF CARBURETION, COMPRESSION, AND IGNITION WHICH WILL CAUSE THE ENGINE TO START.

CHECKING THE STARTER AND STARTER CIRCUIT ON A REGULAR BASIS IS IMPORTANT IN ORDER TO PREVENT FAILURE AT INOPPORTUNE TIMES.

WITH ANY ELECTRICAL EQUIPMENT OR UNIT THE LOGICAL PLACE TO START IS WITH THE BATTERY.

IN THIS JOB ALL TESTS WILL BE MADE WITH THE STARTER AND ACCESSORIES ON THE VEHICLE.

**PROCEDURE:**

| | |
|---|---|
| | TEST BATTERY AS IN JOB VIII-A-5(J) |
| VIII-A-6(TS) | STARTING CIRCUIT TEST |
| VIII-A-6a(TS) | LOAD TEST STARTER |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR PROPER COMPLETION OF JOB

CLEAN WORK STATION AS IN PRECEDING TASKS

## TASK SHEET

VIII-A-6(TS)

**TASK:** STARTING CIRCUIT TEST

**JOB:** TEST AUTOMOBILE CRANKING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** MANUFACTURER'S SPECIFICATIONS, VOLTMETER, HAND TOOLS, ASSORTED OPEN END, REMOTE STARTER JUMPER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CONNECT REMOTE STARTER JUMPER | 1. ON STARTER RELAY SWITCH<br>2. ONE LEAD ON BATTERY TERMINAL OF RELAY ACCORDING TO HOT SIDE OF BATTERY<br>3. ONE LEAD ON STARTER TERMINAL OF RELAY |
| 2. TEST INSULATED CIRCUIT | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER<br>3. ATTACH VOLTMETER TO UNGROUNDED TERMINAL OF BATTERY<br>a. NEGATIVE LEAD OF VOLTMETER TO THE NEGATIVE POST IF UNGROUNDED<br>b. POSITIVE LEAD OF VOLTMETER TO POSITIVE POST IF UNGROUNDED<br>4. ATTACH REMAINING LEAD OF VOLTMETER TO STARTING MOTOR TERMINAL STUD<br>NOTE: SOLENOID EQUIPPED STARTER, USE BATTERY TERMINAL STUD ON SOLENOID<br>5. REMOVE PRIMARY LEAD FROM COIL TO KEEP ENGINE FROM STARTING<br>6. USE REMOTE STARTER, CRANK ENGINE FOR 15 SECONDS<br>7. OBSERVE THE VOLTMETER READING, VOLTAGE DROP SHOULD NOT BE MORE THAN .01 VOLT FOR NORMAL LENGTH, SHORT, INSULATED LEAD<br>NOTE: IF EXCESSIVELY LONG INSULATED LEAD IS USED |

| STEPS | KEY POINTS |
|---|---|
| | a. CHECK SEVERAL VEHICLES WITH SAME HOOK UP TO DETERMINE RESISTANCE<br>b. USE NEW INSULATED CABLE TO CHECK RESISTANCE AND VOLTAGE DROP<br>c. CALCULATE THE RESISTANCE FOR LONG INSULATED LEAD ON VEHICLE<br>8. EXCESSIVE VOLTAGE DROP INDICATES POSSIBLE BAD CONNECTIONS:<br>BATTERY<br>STARTER<br>CABLE<br>GROUND |
| 3. TEST GROUND CIRCUIT | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER<br>3. ATTACH VOLTMETER TO GROUNDED BATTERY TERMINAL<br>4. ATTACH SECOND LEAD OF VOLTMETER TO FRAME OR VEHICLE ENGINE BLOCK DEPENDING ON WHERE GROUND STRAP IS ANCHORED<br>5. ATTACH REMOTE STARTER SWITCH AS IN STEP 1<br>6. REMOVE PRIMARY WIRE FROM IGNITION COIL<br>7. USE REMOTE STARTER SWITCH CRANK ENGINE FOR 15 SECONDS<br>8. OBSERVE THE VOLTMETER READING, VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT<br>9. EXCESSIVE VOLTAGE DROP, CHECK KEY POINT 8 OF STEP 2 |
| 4. TEST BETWEEN GROUND AND STARTER FIELD FRAME | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER<br>3. USE REMOTE STARTER SWITCH AS IN STEP 1<br>4. REMOVE PRIMARY LEAD FROM IGNITION COIL<br>5. ATTACH ONE LEAD OF VOLTMETER TO VEHICLE FRAME OR ENGINE BLOCK |

| STEPS | KEY POINTS |
|---|---|
| | DEPENDING ON WHERE GROUND STRAP IS ANCHORED |
| | 6. ATTACH REMAINING VOLTMETER TO STARTER FIELD FRAME |
| | 7. USE THE REMOTE STARTER SWITCH, CRANK ENGINE FOR 15 SECONDS |
| | 8. OBSERVE THE VOLTMETER READING, VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT |
| | 9. EXCESSIVE VOLTAGE DROP SEE KEY POINT 8 OF STEP 2 |
| 5. TEST SAFETY LOCK OUT SWITCH | 1. AUTOMATIC TRANSMISSION |
| | 2. FOR PROPER ALIGNMENT AND ADJUSTMENT ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS |
| | 3. FOR MECHANICAL FAILURE |
| 6. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET VIII-A-6a(TS)

| | |
|---|---|
| TASK: | LOAD TEST STARTER |
| JOB: | TEST AUTOMOBILE CRANKING SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | STARTER-BATTERY TESTER, REMOTE STARTER JUMPER, 2 ICE PICKS, BATTERY TERMINAL TOOLS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE | 1. START ENGINE<br>2. RUN ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED<br>3. STOP ENGINE<br>4. REMOVE PRIMARY LEAD FROM IGNITION COIL |
| 2. INSTALL REMOTE STARTER JUMPER | 1. ON STARTER RELAY SWITCH<br>2. ONE LEAD ON BATTERY TERMINAL OF RELAY ACCORDING TO HOT SIDE OF BATTERY<br>3. ONE LEAD ON STARTER TERMINAL OF RELAY |
| 3. CONNECT TEST EQUIPMENT | 1. BATTERY-STARTER TESTER<br>2. TO BATTERY<br>3. CONNECT LARGE LEADS<br>a. RED TO POSITIVE POST<br>b. BLACK TO NEGATIVE POST<br>4. GENTLY BUT FIRMLY TAP ONE ICE PICK INTO EACH BATTERY POST<br>5. CONNECT SMALL LEADS<br>a. RED LEAD TO PICK IN POSITIVE POST<br>b. BLACK LEAD TO PICK IN NEGATIVE POST |
| 4. ADJUST TESTER | 1. VARIABLE RESISTANCE<br>2. TO MAXIMUM RESISTANCE<br>NOTE: THIS ADJUSTMENT IS MADE IN ORDER TO PREVENT CURRENT FROM FLOWING THROUGH AMMETER<br>3. USE REMOTE STARTER SWITCH, CRANK |

| | STEPS | | KEY POINTS |
|---|---|---|---|
| | | | ENGINE FOR 15 SECONDS |
| | | 4. | NOTE EXACT READING ON VOLTMETER |
| | | 5. | STOP CRANKING ENGINE |
| | | 6. | READJUST VARIABLE RESISTANCE OF TESTER TO READ EXACTLY THE SAME VOLTAGES AS WHEN THE ENGINE WAS BEING CRANKED |
| 5. | MAKE LOAD TEST | 1. | USE REMOTE STARTER, CRANK ENGINE FOR 15 SECONDS |
| | | 2. | NOTE AMPERAGE DRAW |
| | | | NOTE: THIS AMPERAGE DRAW IS AMPERAGE USED BY THE STARTER UNDER LOAD |
| | | 3. | COMPARE AMPERAGE DRAW NOTED IN KEY POINT 2 WITH MANUFACTURER'S SPECIFICATIONS |
| | | | NOTE: THE USUAL AMPERAGE DRAW IS FROM 150 AMPS TO 200 AMPS. THE AMPERAGE DRAW TEST IS TO DETERMINE WHETHER OR NOT THE STARTING MOTOR MUST BE REMOVED FOR STALL AND NO-LOAD TEST |
| 6. | CLEAN WORK STATION | 1. | AS IN PRECEDING TASKS |
| | | 2. | CHECK WITH INSTRUCTOR FOR COMPLETION OF TEST AND MAKE JUDGMENT OR DECISION CONCERNING DISPOSITION OF STARTER |

# INFORMATION SHEET
# ON
# AUTOMOTIVE CHARGING SYSTEMS

SUBJECT: Drive Belts

## INTRODUCTORY INFORMATION:

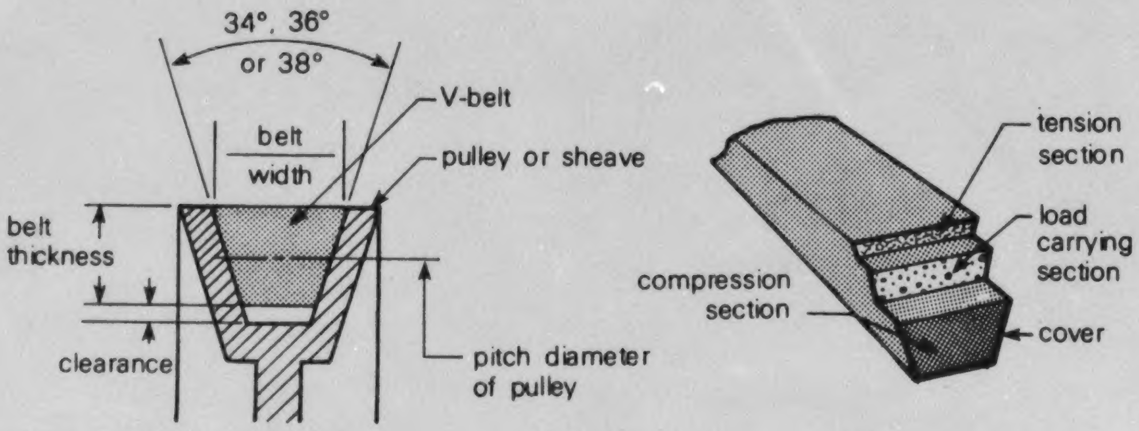
Most automobiles depend upon drive belts to carry power from the engine to the auxiliary power plants on the car such as the charging system, power steering, and air conditioning. Belts are used where positive speed synchronism is not imperative, in that belt drives operate with less noise than chain drives and require no lubrication.

A belt drive consists of an endless flexible belt that connects two wheels or pulleys. Belt drives dependupon friction between the belt and the pulleys for the transmission of power.

There are many types of belt drives, belts, and belting material, but the one which concerns the automobile is the V-belt.

## GENERAL INFORMATION

The V-belt has a trapezoidal cross-section which runs in V-shaped grooves on the pulleys. These belts are constructed of cords and cables, impregnated with a rubber and organic compound, and covered to produce the required cross-section.



Although open end type belting can be purchased, V-belts are manufactured as endless belts and come in a large variety of sizes (cross-sections) and lengths.

Belt manufacturers have developed standards for the various types of V-belts, and these have been issuedas A.S.A. (American Standards Association) for use throughout industry. The three major areas of application are industrial, automotive, and agricultural. Included in these standards are the service conditions as well as belt and sheave dimensions and formulas for figuring center distances. Automobile manufacturers have adopted these standards although their designation (part number) may vary according to each car manufacturer's standard parts list. Dealers and parts houses have cross-index catalogs which give the corresponding belt for each make, model, and engine type and size of most automobiles in service. When ordering replacement belts, these items should be given, plus whether vehicle is air-conditioned. Example: '71 Ford pick-up; 360 HP, automatic w/air conditioning.

V-belt replacement -- the service life of automobiles' V-belts is from three to five years, depending on conditions of the vehicle's service. The V-belts should be checked frequently to insure their condition. Visually check for cuts, cracks, and/or shredding. This may indicate pulley misalignment. Check proper belt tension. Through use and normal wear, belts are inclined to stretch some. Belts which are cut, cracked, or show excessive shredding should be replaced immediately. Correcting the tension or replacing the belt is relatively easy in that all V-belt drives have one pulley that is adjustable. When replacing these belts much care must be undertaken in the adjustment procedure, as a belt that is too tight is likely to damage generator, water pump, or power steering pump bearings and seals. On the other hand, a loose belt can cause overheating of the engine, poor or no charging from the generator, and loss of power steering. Unless precautions are taken upon installation and adjustment many of these things will result, and possibly more damage to the engine could be created.

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-A-7(S)

| | |
|---|---|
| TASK: | TEST D.C. TYPE CHARGING SYSTEM |
| AIM: | THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF A D.C. CHARGING SYSTEM TO DETERMINE NEEDED ADJUSTMENTS OR REPLACEMENT OF SPECIFIC PARTS OF THE CHARGING SYSTEM; USING THE TOOLS AND TEST INSTRUMENTS CALLED FOR IN THE TASK. |
| TOOLS AND EQUIPMENT: | AMMETER, VOLTMETER, TACHOMETER, HYDROMETER, HAND TOOLS, FENDER COVERS, JUMPER LEADS, SEAT COVER, DROPLIGHT |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | WIRING DIAGRAMS, TRANSPARENCIES; I ED II 7T, 192-194, 226-229, 231-234, 237-241; JOB VIII-A-1(J) AND TASK SHEETS |
| REFERENCES: | AUTOMECHANICS, CH. 9<br>AUTOMOTIVE ENCYCLOPEDIA, P. 329<br>AUTO SERVICE AND REPAIR, CH. 22<br>AUTOMOTIVE MECHANICS, CH. 25 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENTS MUST HAVE SATISFACTORILY COMPLETED PRECEDING TASKS IN MAJOR BLOCK VIII. STUDENTS MUST HAVE STUDIED JOB SHEET VIII-A-7(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON ELECTRICITY AND ELECTRICAL COMPONENTS. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. OBSERVE SAFETY STANDARDS<br>3. PREPARATION AND HOOKUP OF TEST EQUIPMENT<br>4. USE OF TEST EQUIPMENT<br>5. TEST RESULTS ACCORDING TO SPECIFICATIONS<br>6. USE OF TOOLS AND EQUIPMENT<br>7. AN ATTITUDE OF APPRECIATION FOR CUSTOMER'S VEHICLE<br>8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN ABNORMAL OPERATION IS NOTED IN A D.C. TYPE CHARGING SYSTEM OF A VEHICLE, IT IS NECESSARY TO MAKE CERTAIN CHECKS TO DETERMINE WHICH OF THE CHARGING SYSTEM COMPONENTS ARE AT FAULT.

## I. PREPARATION (CON'T.)

DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF INSPECTIONS AND TESTS WHICH WILL POINT OUT COMPONENTS OF THE AUTOMOBILE CHARGING SYSTEM THAT MAY BE AT FAULT IN PRODUCING, MAINTAINING, AND CONTROLLING ELECTRICAL OUTPUT. HOOKUP OF TEST EQUIPMENT, TESTING PROCEDURES, AND RECOMMENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. COMPONENTS TO BE TESTED AND INSPECTED | 1. BATTERY<br>2. GENERATOR<br>3. REGULATOR<br>4. WIRING HARNESS |
| 2. VISUAL INSPECTION | ENGINE DEAD |
| A. BATTERY | REFER TO JOB VIII-A-5(S) |
| B. GENERATOR | 1. CLEAN<br>2. ENGINE TO GENERATOR MOUNTING BOLTS TIGHT<br>3. ELECTRICAL TERMINALS<br>a. TERMINAL NUTS TIGHT<br>b. INSULATION IN GOOD CONDITION<br>4. DRIVE PULLEY<br>a. GRASP PULLEY ON EACH SIDE<br>b. EXERT EFFORT ON PULLEY FROM SIDE TO SIDE TO CHECK FOR BEARING WEAR<br>5. REMOVE DUST COVER FROM HOUSING<br>6. CHECK COMMUTATOR FOR WEAR AND CLEANLINESS<br>7. INSPECT BRUSHES FOR WEAR AND CONTACT WITH COMMUTATOR<br>8. DRIVE BELT<br>a. GRASP DRIVE BELT WITH ONE HAND NEAR CENTER BETWEEN PULLEYS<br>b. TWIST DRIVE BELT<br>c. CHECK FOR CRACKS, MISSING SEGMENTS, GLAZE, WEAR, FLEXIBILITY<br>d. CHECK FOR TENSION |

C. WIRING HARNESS

1. BURNED OR CRYSTALLIZED INSULATION
2. CLEAN CONNECTIONS
3. ALL CONNECTIONS TIGHT
4. BROKEN OR CRACKED INSULATION

D. REGULATOR

1. HEAT SPOTS ON COVER
2. COVER NOT BENT, CRACKED, WARPED
3. COVER TIGHT
4. MOUNTING SCREWS TIGHT
5. TERMINAL SCREWS TIGHT

3. NOISE CHECK

1. SET VEHICLE PARK BRAKE
2. PLACE TRANSMISSION IN NEUTRAL
3. START ENGINE
4. GENERATOR
   a. NOISY BEARINGS
   b. ARCING BRUSHES
   c. NOISY BRUSHES
5. DRIVE BELT SQUEAKING
6. STOP ENGINE

4. GENERATOR OUTPUT TEST

1. START ENGINE, ALLOW ALL COMPONENTS OF SYSTEM TO REACH OPERATING TEMPERATURE
2. CHECK THE VEHICLE MANUFACTURER'S SPECIFICATION FOR GENERATOR OUTPUT RATING
3. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES
4. STOP ENGINE
5. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY TERMINAL AND GROUND
6. DISCONNECT REGULATOR "F" TERMINAL LEAD
7. ATTACH JUMPER WIRE TO REGULATOR "F" TERMINAL LEAD
8. ATTACH SECOND END OF JUMPER WIRE TO BASE OF REGULATOR
9. ATTACH SECOND JUMPER LEAD BETWEEN "F" TERMINAL AND "A" TERMINAL ON GENERATOR
10. DISCONNECT "BAT" LEAD FROM REGULATOR

11. CONNECT AMMETER BETWEEN "BAT" TERMINAL ON REGULATOR AND "BAT" DISCONNECTED LEAD
12. START ENGINE
13. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER READING IS 35 AMPERES

NOTE: RPM OF ENGINE NOT TO EXCEED 1500

14. AFTER MAKING TEST RETURN ENGINE RPM TO IDLE
15. COMPARE GENERATOR OUTPUT WITH MANUFACTURER'S RATED OUTPUT

NOTE: IF GENERATOR DOES NOT PRODUCE MANUFACTURER'S RATED OUTPUT AT 1500 RPM OR LESS THE GENERATOR IS NOT FUNCTIONING PROPERLY

16. STOP ENGINE

5. TEST CUTOUT RELAY

1. TEST LEADS AND AMMETER HOOKUP FOR GENERATOR OUTPUT TEST ARE TO REMAIN ATTACHED
2. CONNECT VOLTMETER BETWEEN "GEN" TERMINAL ON REGULATOR AND TO GROUND ON REGULATOR BASE
3. START ENGINE
4. SLOWLY INCREASE ENGINE RPM
5. OBSERVE AMMETER AND VOLTMETER

NOTE: CUTOUT RELAY CLOSING VOLTAGE READING INDICATED ON THE VOLTMETER JUST BEFORE THE AMMETER READING INDICATES CHARGE

6. COMPARE VOLTAGE READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF CLOSING VOLTAGE VARIES FROM SPECIFICATION CUTOUT RELAY SPRING MUST BE ADJUSTED

7. SLOWLY DECREASE ENGINE RPM
8. OBSERVE AMMETER

NOTE: CUTOUT RELAY COUNTERAMPERAGE IS THE LOWEST AMMETER READING BELOW ZERO, JUST BEFORE THE AMMETER INDICATOR SWINGS TO ZERO

9. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF COUNTERAMPERAGE VARIES FROM SPECIFICATION CUTOUT RELAY AIR GAP AND POINT GAP MUST BE ADJUSTED

10. STOP ENGINE

6. TEST VOLTAGE

1. REMOVE JUMPER LEAD FROM REGULATOR "BASE" AND "F" TERMINAL LEAD
2. RECONNECT "F" TERMINAL LEAD TO "F" TERMINAL ON REGULATOR
3. REMOVE AMMETER FROM REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
4. CONNECT A FIXED RESISTOR OF 1/4 OHM BETWEEN THE REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
5. REMOVE VOLTMETER LEAD FROM REGULATOR "GEN" TERMINAL
6. ATTACH VOLTMETER LEAD TO REGULATOR "BAT" TERMINAL
7. SECOND VOLTMETER LEAD REMAINS GROUNDED TO REGULATOR BASE
8. REMOVE JUMPER LEAD FROM GENERATOR "A" AND "F" TERMINALS
9. TACHOMETER REMAINS ATTACHED AS IN GENERATOR TEST
10. START ENGINE
11. INCREASE ENGINE RPM TO 2000
12. OBSERVE VOLTMETER READING
13. STOP ENGINE
14. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF VOLTMETER READING DOES NOT FALL INTO THE SPECIFIED LIMIT, VOLTAGE REGULATOR SPRING TENSION MUST BE ADJUSTED

EXAMPLE: VOLTMETER READING SPECIFIED RANGE BETWEEN 13.5 AND 14.7 VOLTS

7. TEST CURRENT REGULATOR

1. VOLTMETER TO REMAIN ATTACHED AS IN VOLTAGE REGULATOR TEST
2. REMOVE RESISTOR FROM REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
3. CONNECT AMMETER BETWEEN REGULATOR "BAT" TERMINAL AND VARIABLE LOAD CARBON PILE
4. CONNECT VARIABLE LOAD CARBON PILE ACROSS BATTERY, ONE LEAD CONNECTED TO "BAT" TERMINAL LEAD, GROUND SECOND LEAD
5. TURN CARBON PILE SWITCH ON AND TO LOWEST LOAD
6. START ENGINE
7. SET ENGINE RPM AT 1500
8. SLOWLY APPLY LOAD TO BATTERY WITH CARBON PILE
9. OBSERVE THE AMMETER FOR HIGHEST READING
10. STOP ENGINE
11. TURN CARBON PILE SWITCH OFF
12. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS

    NOTE: IF CURRENT REGULATOR SETTING DOES NOT READILY COMPARE WITH SPECIFICATIONS, ADJUST CURRENT REGULATOR
    EXAMPLE: CURRENT OUTPUT MAY BE BETWEEN 34 AND 38 AMPERES

13. REMOVE ALL TEST EQUIPMENT
14. CONNECT "BAT" LEAD TO REGULATOR "BAT" TERMINAL

8. TEST INSULATED CIRCUIT RESISTANCE

1. CONNECT AN AMMETER BETWEEN THE REGULATOR "BAT" TERMINAL AND THE BATTERY
2. CONNECT A VOLTMETER BETWEEN THE BATTERY INSULATED TERMINAL AND THE GENERATOR "A" TERMINAL

3. START THE ENGINE
4. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
5. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED 1 VOLT. IF VOLTAGE LOSS IS MORE THAN 1 VOLT ISOLATE EACH WIRE IN THE CHARGING SYSTEM AND EACH REGULATOR TERMINAL ONE AT A TIME. VOLTAGE LOSS FOR EACH COMPONENT SHOULD NOT EXCEED .2 VOLT

6. STOP ENGINE

9. TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE

1. REMOVE VOLTMETER LEADS FROM THE GENERATOR "A" TERMINAL AND BATTERY INSULATED TERMINAL
2. CONNECT VOLTMETER BETWEEN GENERATOR MOUNTING BRACKET AND BATTERY GROUNDED POST
3. AMMETER REMAINS CONNECTED AS IN INSULATED CIRCUIT TEST
4. START ENGINE
5. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
6. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. IF VOLTAGE LOSS IS GREATER THAN .2 BATTERY TO ENGINE GROUND IS BAD OR GENERATOR TO ENGINE GROUND IS BAD

7. STOP ENGINE

10. TEST REGULATOR GROUND CIRCUIT RESISTANCE

1. REMOVE VOLTMETER LEADS FROM GENERATOR MOUNTING BRACKET AND BATTERY GROUND TERMINAL
2. CONNECT VOLTMETER BETWEEN REGULATOR BASE AND GENERATOR MOUNTING BRACKET
3. START ENGINE
4. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
5. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. VOLTAGE LOSS ABOVE .2 VOLT WILL AFFECT CUTOUT RELAY AND VOLTAGE REGULATOR CAUSING THEM TO FUNCTION AT A HIGHER SETTING THAN THE ACTUAL ADJUSTMENT

6. STOP ENGINE
7. REMOVE TEST EQUIPMENT

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## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

STUDENTS TO PRACTICE ON THE JOB UNDER CLOSE SUPERVISION. STUDENTS TO BE FURNISHED WITH JOBAND TASK SHEETS TO FOLLOWWHILE PERFORMING THE JOB. STUDENTS SHOULD CHECK WITH INSTRUCTOR AT FREQUENT INTERVALS.

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## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM JOB. USE PERFORMANCE TEST.

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## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

EMPHASIZE TYPES OF TESTS

1. VISUAL
2. AUDIO
3. GENERATOR OUTPUT
4. CUTOUT RELAY
5. VOLTAGE REGULATOR
6. CURRENT REGULATOR
7. INSULATED CIRCUIT RESISTANCE
8. CHARGING SYSTEM GROUND CIRCUIT RESISTANCE
9. REGULATOR GROUND CIRCUIT RESISTANCE

REPEAT TEST EQUIPMENT HOOKUP FOR EACH TEST.

EMPHASIZE CAUTION CONCERNING POSSIBLE DAMAGE TO GENERATOR AND REGULATOR DURING TESTS.

EMPHASIZE SAFETY.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN, PP.
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP.
AUTO SERVICE AND REPAIR, STOCKEL,
AUTOMOTIVE MECHANICS, CROUSE,

THE NEXT LESSON IS: VIII-A-8(S), "TEST A.C. TYPE CHARGE SYSTEM"

# JOB SHEET
# IN
# CHARGING SYSTEM

VIII-A-7(J)

**JOB:** TEST D. C. CHARGING SYSTEM

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** AMMETER, VOLTMETER, HYDROMETER, HAND TOOLS, FENDER COVER, SEAT COVERS, JUMPER LEADS, DROPLIGHT, TACHOMETER, 1/4 OHM RESISTOR, VARIABLE LOAD CARBON PILE

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCE MATERIAL. STUDY JOB AND TASK SHEETS. BE SURE FENDER COVERS ARE IN POSITION ON THE VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO LOCATE THE CHARGING SYSTEM PART WHICH MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE NEEDED MAINTENANCE TO CORRECT CHARGING SYSTEM PROBLEMS.

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-A-7(TS) | INSPECT CHARGING SYSTEM |
| VIII-A-7a(TS) | TEST GENERATOR OUTPUT |
| VIII-A-7b(TS) | TEST CUTOUT RELAY |
| VIII-A-7c(TS) | TEST VOLTAGE REGULATOR |
| VIII-A-7d(TS) | TEST CURRENT REGULATOR |
| VIII-A-7e(TS) | TEST INSULATED CIRCUIT RESISTANCE |
| VIII-A-7f(TS) | TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE |
| VIII-A-7g(TS) | TEST REGULATOR GROUND CIRCUIT RESISTANCE |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

| | |
|---|---|
| VIII-A-5(S) | SERVICE STORAGE BATTERY |
| VIII-A-6a(TS) | CLEAN WORK STATION |

TASK SHEET VIII-A-7 (TS)

**TASK:** INSPECT CHARGING SYSTEM

**JOB:** TEST D. C. CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, FENDER COVER, DROPLIGHT, SEAT COVER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. OPEN HOOD<br>2. PLACE FENDER COVERS OVER FENDERS<br>3. POSITION DROPLIGHT<br>a. UNDER HOOD<br>b. PLUGGED INTO POWER OUTLET<br>c. TURNED ON<br>4. PLACE SEAT COVER OVER DRIVER'S SEAT<br>5. SET PARK BRAKE<br>6. PLACE TRANSMISSION IN NEUTRAL |
| 3. VISUALLY INSPECT BATTERY | AS IN VIII-A-5(J) |
| 4. VISUALLY INSPECT GENERATOR | 1. CLEAN CONDITION<br>2. GENERATOR TO THE ENGINE MOUNTING BOLTS TIGHT<br>3. ELECTRICAL TERMINALS<br>a. TERMINAL NUTS TIGHT<br>b. TERMINAL INSULATION IN GOOD CONDITION<br>4. DRIVE PULLEY<br>a. GRASP PULLEY ON EACH SIDE<br>b. EXTEND PRESSURE ON THE PULLEY FROM SIDE TO SIDE, CHECK FOR BEARING WEAR<br>5. REMOVE DUST COVER FROM HOUSING<br>6. CHECK COMMUTATOR FOR WEAR AND CLEANLINESS<br>7. INSPECT BRUSHES FOR WEAR AND CONTACT WITH COMMUTATOR |

| STEPS | KEY POINTS |
|---|---|
| | 8. CHECK BRUSH SPRING TENSION |
| 5. VISUALLY INSPECT DRIVE BELT | 1. CHECK FOR PROPER TENSION ADJUSTMENT |
| | 2. CHECK BELT GENERAL CONDITION |
| | a. GRASP BELT NEAR CENTER BETWEEN PULLEYS |
| | b. TWIST BELT EXPOSING BOTTOM SIDE |
| | c. CHECK FOR CRACKS, MISSING SEGMENTS, WEAR, GLAZE, FLEXIBILITY |
| | 3. RELEASE BELT |
| 6. VISUALLY INSPECT WIRING SYSTEM | 1. BURNED OR CRYSTALLIZED INSULATION |
| | 2. BROKEN OR CRACKED INSULATION |
| | 3. BROKEN WIRES |
| | 4. TERMINALS FIRMLY ATTACHED TO THE WIRES |
| | 5. CLEAN CONDITION |
| | 6. CONNECTIONS TIGHT AT ALL TERMINAL POINTS |
| 7. VISUALLY INSPECT REGULATOR | 1. LOOK FOR HEAT SPOTS ON COVER |
| | 2. LOOK FOR DENTS AND DEPRESSIONS IN COVER |
| | 3. COVER TIGHT |
| | 4. MOUNTING SCREWS TIGHT |
| | 5. TERMINAL SCREWS TIGHT |
| 8. NOISE CHECK | 1. START ENGINE |
| | 2. CHECK GENERATOR FOR NOISY BEARINGS |
| | 3. CHECK THE GENERATOR FOR NOISY BRUSHES |
| | 4. CHECK THE GENERATOR FOR ARCING BRUSHES |
| | 5. CHECK DRIVE BELT FOR SQUEAKING |
| | 6. STOP ENGINE |
| | 7. REPLACE DUST COVER ON GENERATOR |
| 9. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-A-7a(TS)

TASK: TEST GENERATOR OUTPUT

JOB: TEST D. C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: AMMETER, VOLTMETER, JUMPER LEADS, HAND TOOLS, FENDER COVERS, SEAT COVER, DROPLIGHT, TACHOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. AS IN VIII-A-4(TS)<br>2. START ENGINE, ALLOW ALL CHARGING SYSTEM COMPONENTS TO REACH THE OPERATING TEMPERATURE<br>3. STOP ENGINE |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR THE GENERATOR OUTPUT RATING<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BE DAMAGED |
| B. CONNECT JUMPER LEADS | 1. REMOVE TERMINAL LEAD FROM REGULATOR "F" TERMINAL<br>2. ATTACH JUMPER LEAD TO "F" TERMINAL LEAD<br>3. ATTACH SECOND END OF JUMPER LEAD TO BASE OF REGULATOR, MAKING A GROUND<br>4. CONNECT SECOND JUMPER LEAD BETWEEN "A" AND "F" TERMINALS ON GENERATOR |
| C. CONNECT AMMETER | 1. REMOVE TERMINAL LEAD FROM REGULATOR "BAT" TERMINAL |

| STEPS | KEY POINTS |
|---|---|
| | 2. ATTACH ONE AMMETER LEAD TO REGULATOR "BAT" TERMINAL |
| | 3. ATTACH SECOND AMMETER LEAD TO REGULATOR "BAT" TERMINAL LEAD |
| | 4. POSITION AMMETER WHERE IT CAN BE READILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BECOME DAMAGED |
| 4. TEST GENERATOR OUTPUT | 1. START ENGINE |
| | 2. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER READING IS 35 AMPERES |
| | NOTE: ENGINE RPM IS NOT TO EXCEED 1500 |
| | 3. STOP ENGINE IMMEDIATELY AFTER TEST HAS BEEN PERFORMED |
| | 4. COMPARE GENERATOR TEST OUTPUT WITH MANUFACTURER'S RATED OUTPUT |
| | NOTE: IF GENERATOR DOES NOT PRODUCE MANUFACTURER'S RATED OUTPUT AT 1500 RPM OR LESS IT IS NOT FUNCTIONING PROPERLY AND MUST BE REPLACED OR SERVICED |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. CONNECT ALL LEAD TO PROPER POSITION |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

**TASK:** TEST CUTOUT RELAY

**JOB:** TEST D.C. CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** VOLTMETER, AMMETER, FENDER COVERS, SEAT COVERS, JUMPER LEADS, DROPLIGHT, HAND TOOLS, TACHOMETER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. AS IN PRECEDING TASKS<br>2. AS IN TASK VIII-A-4a(TS) |
| 3. CONNECT TEST INSTRUMENTS | 1. REFER TO TASK VIII-A-4a(TS)<br>2. CONNECT VOLTMETER BETWEEN REGULATOR "GEN" TERMINAL AND TO THE GROUND ON REGULATOR BASE |
| 4. TEST CUTOUT RELAY | 1. START ENGINE<br>2. SLOWLY INCREASE ENGINE RPM<br>3. OBSERVE AMMETER AND VOLTMETER<br>NOTE: CUTOUT RELAY CLOSING VOLTAGE IS THE HIGHEST VOLTAGE READING INDICATED ON THE VOLTMETER JUST BEFORE THE AMMETER READING INDICATES CHANGE<br>4. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS<br>NOTE: IF CLOSING VOLTAGE VARIES FROM SPECIFICATIONS, CUTOUT RELAY SPRING TENSION MUST BE ADJUSTED<br>5. SLOWLY DECREASE ENGINE RPM<br>6. OBSERVE AMMETER<br>NOTE: CUTOUT RELAY COUNTERAMPERAGE IS THE LOWEST AMMETER READING BELOW ZERO, JUST BEFORE THE AMMETER INDICATOR SWINGS TO ZERO<br>7. STOP ENGINE |

| STEPS | KEY POINTS |
|---|---|
| | 8. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS |
| | NOTE: IF COUNTERAMPERAGE VARIES FROM SPECIFICATIONS, CUTOUT RELAY AIR GAP AND POINT GAP MUST BE ADJUSTED |
| | 9. REMOVE TEST EQUIPMENT |
| | 10. CONNECT ALL LEADS TO THE PROPER POSITION |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

TASK: TEST VOLTAGE REGULATOR

JOB: TEST D. C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, FENDER COVERS, SEAT COVER, 1/4 OHM FIXED RESISTOR, TACHOMETER, DROPLIGHT

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN TASK VIII-A-4(TS) |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR VOLTAGE REGULATOR SETTING<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BE DAMAGED |
| B. CONNECT RESISTOR | 1. REMOVE TERMINAL LEAD FROM REGULATOR "BAT" TERMINAL<br>2. CONNECT ONE LEAD OF A 1/4 OHM FIXED RESISTOR TO THE "BAT" REGULATOR TERMINAL<br>3. CONNECT SECOND LEAD OF THE 1/4 OHM RESISTOR TO THE "BAT" TERMINAL LEAD |
| C. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO THE REGULATOR "BAT" TERMINAL WITH THE RESISTOR<br>2. CONNECT SECOND LEAD OF THE VOLTMETER TO REGULATOR BASE<br>3. POSITION VOLTMETER WHERE IT CAN BE READILY OBSERVED AND OUT OF |

| STEPS | KEY POINTS |
|---|---|
| | THE WAY SO THAT IT WILL NOT BECOME DAMAGED |
| 4. TEST VOLTAGE REGULATOR | 1. START ENGINE<br>2. INCREASE ENGINE RPM TO 2000<br>3. OBSERVE VOLTMETER READING<br>4. STOP ENGINE<br>5. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS<br>NOTE: IF VOLTMETER READING DOES NOT FALL INTO THE SPECIFIED LIMIT, VOLTAGE REGULATOR SPRING TENSION MUST BE ADJUSTED<br>EXAMPLE: VOLTMETER READING SPECIFIED RANGE MAY BE BETWEEN 13.5 AND 14.7 VOLTS<br>6. REMOVE TEST EQUIPMENT<br>7. CONNECT ALL THE CHARGING SYSTEM LEADS TO PROPER TERMINALS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-A-7d(TS)

TASK: TEST CURRENT REGULATOR

JOB: TEST D. C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, AMMETER, TACHOMETER, VARIABLE LOAD CARBON PILE, FENDER COVERS, SEAT COVERS, DROPLIGHT, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | |
| 2. PREPARE VEHICLE | 1. AS IN TASK VIII-A-4(TS)<br>2. AS IN TASK VIII-A-4a(TS) |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CURRENT REGULATOR SETTINGS<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BECOME DAMAGED |
| B. CONNECT VOLTMETER | 1. DISCONNECT REGULATOR "BAT" TERMINAL LEAD<br>2. CONNECT ONE VOLTMETER LEAD TO REGULATOR "BAT" TERMINAL<br>3. CONNECT SECOND VOLTMETER LEAD TO BASE OF REGULATOR<br>4. POSITION VOLTMETER WHERE IT CAN BE READILY OBSERVED BUT OUT OF THE WAY |
| C. CONNECT CARBON PILE | 1. CONNECT ONE LEAD OF THE VARIABLE LOAD CARBON PILE TO "BAT" TERMINAL LEAD |

| STEPS | KEY POINTS |
|---|---|
| | 2. CONNECT SECOND LEAD OF VARIABLE CARBON PILE TO GROUND |
| | 3. POSITION CARBON PILE OUT OF WAY BUT HANDY |
| D. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL |
| | 2. CONNECT SECOND LEAD OF AMMETER TO TERMINAL ON CARBON PILE WHERE "BAT" TERMINAL LEAD IS ATTACHED |
| | 3. POSITION AMMETER WHERE IT CAN BE READILY OBSERVED BUT OUT OF THE WAY |
| 4. TEST CURRENT | 1. TURN CARBON PILE SWITCH TO LOWEST LOAD |
| | 2. START ENGINE |
| | 3. SET ENGINE RPM AT 1500 |
| | 4. SLOWLY APPLY LOAD TO BATTERY WITH CARBON PILE |
| | 5. OBSERVE THE AMMETER FOR HIGHEST READING |
| | 6. STOP ENGINE |
| | 7. TURN CARBON PILE SWITCH OFF |
| | 8. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS |
| | NOTE: IF CURRENT REGULATOR SETTING DOES NOT READILY COMPARE WITH SPECIFICATIONS ADJUST CURRENT REGULATOR<br>EXAMPLE: CURRENT OUTPUT MAY BE BETWEEN 34 AND 38 AMPERES |
| | 9. REMOVE TEST INSTRUMENTS |
| | 10. CONNECT ALL LEADS TO PROPER TERMINAL |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

# TASK SHEET

VIII-A-7e(TS)

TASK: TEST INSULATED CIRCUIT RESISTANCE

JOB: TEST D. C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVERS, DROPLIGHT, VOLTMETER, AMMETER, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN TASK VIII-A-4(TS) AND TASK VIII-A-4a(TS) |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK VIII-A-4a(TS) STEP E, KEY POINTS 1 AND 2 |
| A. CONNECT AMMETER | 1. CONNECT ONE AMMETER LEAD TO THE REGULATOR "BAT" TERMINAL<br>2. CONNECT SECOND AMMETER LEAD TO BATTERY INSULATED TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT VOLTMETER | 1. CONNECT ONE VOLTMETER LEAD TO BATTERY INSULATED TERMINAL<br>2. CONNECT SECOND VOLTMETER LEAD TO GENERATOR "A" TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST INSULATED CIRCUIT | 1. FOR RESISTANCE<br>2. START ENGINE<br>3. INCREASE ENGINE RPM SLOWLY UNTIL AMMETER INDICATES THE 20 AMPERE CHARGE<br>4. OBSERVE VOLTMETER READING<br>NOTE: VOLTAGE LOSS IS NOT TO EXCEED 1 VOLT. IF VOLTAGE LOSS IS GREATER THAN 1 VOLT, USE VOLTMETER, ISOLATE EACH WIRE AND EACH REGULATOR TERMINAL IN THE CHARGING SYSTEM ONE AT A TIME. VOLTAGE |

| STEPS | KEY POINTS |
|---|---|
| | LOSS FOR EACH COMPONENT SHOULD NOT EXCEED .2 VOLT |
| | 5. STOP ENGINE<br>6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-A-7f(TS)

TASK: TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, AMMETER, FENDER COVERS, SEAT COVER, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN TASK VIII-A-4(TS) AND TASK VIII-A-4a(TS) |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK VIII-A-4a(TS) STEP 3, KEY POINTS 1 AND 2 |
| A. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO GENERATOR MOUNTING BRACKET<br>2. CONNECT SECOND VOLTMETER LEAD TO BATTERY GROUND TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL<br>2. CONNECT SECOND LEAD OF AMMETER TO BATTERY INSULATED TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST CHARGING SYSTEM GROUND CIRCUIT | 1. FOR RESISTANCE<br>2. START ENGINE<br>3. INCREASE ENGINE RPM SLOWLY UNTIL THE AMMETER INDICATES 20 AMPERE CHARGE<br>4. OBSERVE VOLTMETER READING<br>NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. IF VOLTAGE LOSS IS GREATER THAN .2 VOLT BATTERY TO ENGINE GROUND IS BAD OR GENERATOR TO ENGINE GROUND IS BAD<br>5. STOP ENGINE |

| STEPS | KEY POINTS |
|---|---|
| | 6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-A-7g(TS)

**TASK:** TEST REGULATOR GROUND CIRCUIT RESISTANCE

**JOB:** TEST D.C. CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** VOLTMETER, AMMETER, FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN TASK VIII-A-4(TS) AND TASK VIII-A-4a(TS) |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK VIII-A-4a(TS) STEP 3, KEY POINTS 1 AND 2 |
| A. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO GENERATOR MOUNTING FRAME<br>2. CONNECT SECOND VOLTMETER LEAD TO REGULATOR BASE<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL<br>2. CONNECT SECOND LEAD OF AMMETER TO BATTERY INSULATED BATTERY<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST REGULATOR GROUND CIRCUIT | 1. FOR RESISTANCE<br>2. START ENGINE<br>3. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER INDICATES THE 20 AMPERE CHARGE<br>4. OBSERVE VOLTMETER READING<br>NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. VOLTAGE LOSS ABOVE .2 VOLT WILL AFFECT CUTOUT RELAY AND REGULATOR SETTINGS. GREATER VOLTAGE LOSS WILL CAUSE THEM TO FUNCTION AT A HIGHER SETTING THAN THE ACTUAL ADJUSTMENT |

| STEPS | KEY POINTS |
|---|---|
| | 5. STOP ENGINE |
| | 6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

VIII-A-8(S)

# INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

TASK: TEST A. C. TYPE CHARGING SYSTEM

AIM: THE STUDENT WILL BE ABLE TO TEST AND DIAGNOSE A. C. CHARGING SYSTEM COMPONENTS USING REQUIRED TEST EQUIPMENT AND MANUFACTURER'S SPECIFICATIONS AND MAKE JUDGMENTS AND DECISIONS CONCERNING NEEDED SERVICE OR REPAIR.

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROPLIGHT, AMMETER, VOLTMETER, BELT ADJUSTING GAUGE, TACHOMETER, PRY BAR, HAND TOOLS, REGULATOR, THERMOMETER, BATTERY TESTER

MATERIALS: CLEAN RAGS

TEACHING AIDS: JOB AND TASK SHEETS, TRANSPARENCIES I ED II 7T, FIGS. 192-194, 226-229, 231-234, 237, 241

REFERENCES:
AUTOMECHANICS, PP. 272-277
AUTOMOTIVE ENCYCLOPEDIA, PP. 348-351
AUTO SERVICE AND REPAIR, PP. 22-22 TO 22-26
AUTOMOTIVE MECHANICS, PP. 226-236, 357-359

PREREQUISITE EXPERIENCE OF THE LEARNER: THE STUDENT MUST BE ABLE TO IDENTIFY THE PARTS OF AN A. C. CHARGING SYSTEM, MUST HAVE READ THE REFERENCES, AND HAVE STUDIED THE JOB AND TASK SHEETS.

CHECKING STANDARDS:

1. SELECTION OF TOOLS AND EQUIPMENT
2. TEST EQUIPMENT HOOKUP
3. CRAFTSMANLIKE PERFORMANCE OF TASK
4. ACCURACY OF TEST RESULTS
5. APPRECIATION FOR TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE
6. SAFE WORKING HABITS

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## I. PREPARATION (OF THE LEARNER-MOTIVATION)

NORMAL OPERATION FAILURE OF AN ALTERNATOR IS NOTED THROUGH SEVERAL DIFFERENT TYPES AND KINDS OF SYMPTOMS.

THE ALTERNATOR WILL HUM OR WHINE AT LOW SPEEDS OR IDLE WHEN A DIODE IS DEFECTIVE. AN ALTERNATOR IS A THREE-PHASE MACHINE; THEREFORE, WHEN A DIODE IS DEFECTIVE THE ALTERNATOR IS OUT OF SOUND PHASE, CAUSING THE HUM OR WHINE. THIS CAN BE THE RESULT OF A SHORTED DIODE.

AN OPEN DIODE CAUSES THE UNIT TO BECOME ELECTRICALLY UNBALANCED, THEREBY CAUSING A PHYSICAL UNBALANCE OF THE UNIT. WHEN AN ALTERNATOR OPERATES UNDER THESE CONDITIONS IT IS NOISY. IF THIS CONDITION IS NOT CORRECTED THE DIODE END FRAME BUSHINGS OR BEARINGS WILL BECOME DAMAGED.

AN ALTERNATOR WITH FAULTY DIODES CAN SUPPLY THE IGNITION SYSTEM WITH SUFFICIENT CURRENT BUT WILL NOT BE ADEQUATE WHEN OTHER ELECTRICAL APPARATUS IS USED.

THE USUAL ALTERNATOR PROBLEM IS IN THE DIODES. DIODE PROBLEMS ARE USUALLY CREATED BY CARELESS OR UNSKILLED PRACTICES.

USUAL TESTS TO BE USED ON THE ALTERNATOR SYSTEM CONSIST OF:

1. BELT TENSION
2. BATTERY CONDITION
3. CIRCUIT TESTS
4. ALTERNATOR
    a. FIELD CURRENT DRAW TEST
    b. OUTPUT TEST
5. REGULATOR TEST

---

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION THE VEHICLE AS IN PRECEDING TASKS<br>2. RAISE THE HOOD AND INSTALL FENDER COVERS |
| 2. CHECK DRIVE BELT | 1. GENERAL CONDITION AS D. C. GENERATOR<br>2. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT BELT TENSION<br>NOTE: ALTERNATOR DRIVE BELT TENSION IS CRITICAL BECAUSE THE DRIVE PULLEY IS SMALL AND HAS LITTLE WRAP AROUND DRIVE BELT ACTION. TOO LOOSE BELT WILL SLIP. TOO TIGHT END FRAME BEARING IS DAMAGED<br>3. LOOSEN SUPPORT BRACKET BOLTS<br>4. LOOSEN BELT ADJUSTING BOLT |

5. PLACE PRY BAR BETWEEN ENGINE AND HEAVY FRONT SECTION OF ALTERNATOR HOUSING

CAUTION: CARE MUST BE TAKEN NOT TO CRUSH THE ALTERNATOR HOUSING WITH THE PRY BAR

6. TIGHTEN BELT BY PRYING ALTERNATOR AWAY FROM ENGINE
7. HOLD BAR WITH ONE HAND
8. DEPRESS CENTER OF BELT BETWEEN PULLEYS WITH OTHER HAND
9. ESTIMATE ONE-HALF INCH DEPRESSION
10. TIGHTEN BELT ADJUSTMENT BOLT
11. USE BELT ADJUSTING GAUGE FOR SPECIFIED TENSION CHECK
12. TIGHTEN SUPPORT BRACKET BOLTS

3. CHECK BATTERY CONDITIONS

REFER TO JOB VIII-A-5(J)

4. FIELD CIRCUIT RESISTANCE TEST

1. REMOVE BATTERY GROUND TERMINAL LEAD
2. REMOVE IGNITION WIRE AT COIL SIDE OF BALLAST RESISTOR
3. CONNECT NEGATIVE VOLTMETER LEAD TO FIELD TERMINAL OF REGULATOR AND POSITIVE LEAD TO POSITIVE POST OF BATTERY

NOTE: ALL ACCESSORIES AND LIGHTS ARE TO BE TURNED OFF

4. REPLACE BATTERY GROUND LEAD
5. TURN IGNITION SWITCH ON
6. TAKE READING FROM VOLTMETER

NOTE: VOLTAGE READING IS NOT TO EXCEED .55 VOLT. A READING ABOVE .55 VOLT INDICATES HIGH RESISTANCE IN FIELD CIRCUIT BETWEEN REGULATOR FIELD TERMINAL AND BATTERY

7. IF HIGH RESISTANCE IS INDICATED MOVE NEGATIVE VOLTMETER LEAD TO EACH TERMINAL IN THE CIRCUIT TO THE BATTERY

NOTE: IF THERE IS A SUDDEN DROP IN THE VOLTAGE READING THERE IS A LOOSE OR CORRODED TERMINAL BETWEEN THE TERMINAL BEING TESTED AND THE PRECEDING TERMINAL

8. MOVE THE NEGATIVE VOLTMETER LEAD BACK TO THE NEXT TERMINAL
   a. GRASP THE TERMINAL BEING TESTED AND ATTEMPT TO MOVE IT
   b. WATCH THE VOLTMETER

NOTE: ANY MOVEMENT OF THE VOLTMETER NEEDLE INDICATES A LOOSE TERMINAL OR IT IS MAKING PARTIAL CONTACT THROUGH THE CORROSION

   c. TIGHTEN OR CLEAN TERMINAL
9. TURN OFF IGNITION
10. REMOVE BATTERY NEGATIVE TERMINAL LEAD
11. DISCONNECT VOLTMETER
12. CONNECT IGNITION PRIMARY LEAD TO BALLAST RESISTOR TERMINAL

5. CHARGING

1. DISCONNECT "BAT" LEAD FROM ALTERNATOR OUTPUT TERMINAL
2. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND "BAT" LEAD
3. CONNECT POSITIVE LEAD OF VOLTMETER TO "BAT" LEAD
4. CONNECT NEGATIVE LEAD OF VOLTMETER TO BATTERY POSITIVE POST
5. DISCONNECT FIELD LEAD FROM ALTERNATOR TO VOLTAGE REGULATOR AT ALTERNATOR
6. CONNECT JUMPER LEAD FROM ALTERNATOR FIELD TERMINAL TO GROUND
7. TACHOMETER BETWEEN PRIMARY DISTRIBUTOR LEAD AND GROUND
8. CONNECT BATTERY NEGATIVE GROUND LEAD
9. TURN CARBON PILE SWITCH TO OFF POSITION
10. CONNECT CARBON PILE SWITCH BETWEEN BATTERY TERMINALS

11. START ENGINE
12. RUN ENGINE AT IDLE SPEED
13. ADJUST ENGINE RPM AND CARBON PILE SWITCH
    a. TO MAINTAIN 20 AMPERE FLOW IN CHARGING SYSTEM
    b. VOLTMETER READING IS NOT TO EXCEED .7 VOLT

NOTE: IF VOLTMETER READING IS ABOVE .7 VOLT INSPECT, CLEAN, AND TIGHTEN ALL CHARGING CIRCUIT CONNECTIONS

NOTE: PERFORM VOLTAGE DROP TEST AT EACH TERMINAL TO LOCATE TERMINAL WITH EXCESSIVE RESISTANCE

14. IDLE ENGINE
15. TURN OFF CARBON PILE SWITCH
16. STOP ENGINE
17. DISCONNECT BATTERY NEGATIVE LEAD
18. REMOVE ALL TEST EQUIPMENT
19. CONNECT FIELDWIRE TO ALTERNATOR FIELD TERMINAL

6. ALTERNATOR CURRENT OUTPUT TEST

NOTE: TEST IS PERFORMED TO DEMINE THAT ALTERNATOR WILL DELIVER RATED CURRENT OUTPUT

1. REMOVE "BAT" LEAD AT ALTERNATOR OUTPUT TERMINAL
2. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND "BAT" LEAD
3. CONNECT VOLTMETER POSITIVE LEAD TO ALTERNATOR "BAT" TERMINAL
4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND
5. REMOVE ALTERNATOR TO VOLTAGE REGULATOR FIELD LEAD AT ALTERNATOR
6. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL AND GOOD GROUND
7. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY LEAD AND GOOD

GROUND

8. TURN CARBON PILE SWITCH TO OFF
9. CONNECT CARBON PILE BETWEEN BATTERY TERMINALS
10. CONNECT BATTERY NEGATIVE LEAD
11. START ENGINE AND RUN AT IDLE RPM
12. GRADUALLY INCREASE ENGINE SPEED TO 1250 RPM
13. ADJUST CARBON PILE UNTIL VOLTMETER READING IS 15 VOLTS

CAUTION: VOLTMETER IS NOT TO REACH A READING ABOVE 16 VOLTS

14. CHECK MANUFACTURER'S SPECIFICATIONS FOR ALTERNATOR OUTPUT LIMITS

NOTE: IF AMMETER READING IS LESS THAN SPECIFIED LIMITS ALTERNATOR SHOULD BE REMOVED FROM THE VEHICLE AND BENCH TESTED

15. TURN OFF CARBON PILE SWITCH
16. ADJUST ENGINE IDLE RPM
17. STOP ENGINE
18. REMOVE BATTERY NEGATIVE LEAD
19. REMOVE TEST EQUIPMENT
20. CONNECT "BAT" LEAD TO ALTERNATOR "BAT" TERMINAL
21. CONNECT FIELD LEAD TO ALTERNATOR

7. ELECTRONIC VOLTAGE REGULATOR TEST

1. REMOVE BATTERY TERMINAL LEADS
2. THOROUGHLY CLEAN AND SERVICE BATTERY POSTS AND LEAD CONNECTORS
3. CONNECT VOLTMETER POSITIVE LEAD TO IGNITION NUMBER ONE TERMINAL AT BALLAST RESISTOR
4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND
5. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY LEAD AND A GOOD GROUND
6. CONNECT BATTERY LEADS TO BATTERY
7. START ENGINE

8. SET ENGINE SPEED AT 1250

NOTE: NO LIGHTS OR ACCESSORIES ARE TO BE ON

9. CHECK MANUFACTURER'S SPECIFICATIONS FOR AMBIENT AIR TEMPERATURE AND CORRESPONDING VOLTAGE READING LIMITS

A. VOLTAGE READING BELOW SPECIFICATIONS TEST

1. STOP ENGINE
2. MAKE REGULATOR GROUND TEST, USE TASK SHEET VIII-A-4g(TS)
3. TURN OFF IGNITION SWITCH
4. DISCONNECT REGULATOR CONNECTOR
5. TURN ON IGNITION SWITCH, ENGINE IS NOT TO BE STARTED
6. CHECK FOR BATTERY VOLTAGE
   a. USE VOLTMETER
   b. PROBE BOTH WIRING HARNESS TERMINALS

NOTE: NO VOLTAGE AT EITHER LEAD
a. PROBLEM IS IN VEHICLE WIRING
b. "OR" ALTERNATOR FIELD CIRCUIT

NOTE: VOLTAGE PRESENT AT BOTH LEADS REPLACE REGULATOR

7. CONNECT TO REGULATOR CONNECTOR

B. VOLTAGE READING HIGHER THAN SPECIFICATIONS TEST

1. MAKE REGULATOR GROUND TEST, USE TASK SHEET VIII-A-7g(TS)
2. MAKE SYSTEM GROUND CIRCUIT TEST, USE TASK SHEET VIII-A-7g(TS)

NOTE: SYSTEM AND REGULATOR HAVE PROPER GROUND, PROBLEM IS INTERNAL AND VOLTAGE REGULATOR MUST BE REPLACED

3. REMOVE TEST EQUIPMENT

NOTE: ALL OTHER REGULATOR TESTS ARE MADE THE SAME AS FOR A D. C. CHARGING SYSTEM

8. ROTOR FIELD COIL DRAW TEST

1. DISCONNECT BATTERY NEGATIVE LEAD

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NOTE: TEST IS MADE TO TEST ALTERNATOR INTERNAL FIELD CIRCUIT. TEST MAY BE PERFORMED WITH ALTERNATOR ON THE VEHICLE OR AS A BENCH TEST

2. LOOSEN ALTERNATOR DRIVE BELT AS IN STEP 2 OF THIS LESSON
3. MARK AND REMOVE LEADS FROM ALTERNATOR
4. TEST BATTERY FOR FULL CHARGE
5. CONNECT JUMPER LEAD BETWEEN ONE ALTERNATOR FIELD TERMINAL AND BATTERY POSITIVE POST
6. CONNECT AMMETER POSITIVE LEAD TO SECOND FIELD TERMINAL ON ALTERNATOR
7. CONNECT AMMETER NEGATIVE LEAD TO BATTERY NEGATIVE POST
8. SLOWLY ROTATE ALTERNATOR PULLEY BY HAND
9. OBSERVE AMMETER READING

NOTE: AMMETER READING SHOULD INDICATE FIELD COIL DRAWS BETWEEN 2.5 AND 3.1 AMPERES.

a. LOW AMMETER READING-HIGH RESISTANCE IN ROTOR, SLIP RINGS, OR BRUSHES
b. HIGH AMMETER READING-SHORTED OR GROUNDED ROTOR
c. NO AMMETER READING-OPEN ROTOR OR DEFECTIVE BRUSHES

10. ADJUST DRIVE BELT AS IN STEP 2 OF THIS LESSON
11. CONNECT ALTERNATOR LEADS ACCORDING TO MARKINGS
12. CONNECT BATTERY NEGATIVE LEAD

9. CLEAN WORK STATION — AS IN PRECEDING TASKS

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION.
2. STUDENTS TO USE JOB AND TASK SHEETS.

## III. APPLICATION (CON'T)

3. RETEACH IF THE NEED ARISES.
4. ASK QUESTIONS ABOUT STEPS AND KEY POINTS AS STUDENTS PERFORM TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. STUDENTS TO BE PLACED ON THEIR OWN TO PERFORM JOB.
2. USE PERFORMANCE TEST.
3. CHECK STUDENTS FOR ACCURACY OF RESULTS.
4. POST RESULTS ON PROGRESS CHART.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE REMOVAL OF BATTERY NEGATIVE LEAD BEFORE MAKING ANY TEST HOOKUPS.
2. EMPHASIZE THE NEED FOR CAUTION NOT TO DAMAGE ALTERNATOR THROUGH CARELESS PREPARATIONS AND PROCEDURES.
3. EMPHASIZE SAFE WORKING HABITS.
4. EMPHASIZE THE FACT THAT THE BATTERY MUST BE CHECKED FIRST BEFORE MAKING ANY ATTEMPT TO TEST OTHER PARTS OF A CHARGING SYSTEM.
5. EMPHASIZE THE NEED FOR ACCURACY WHEN ADJUSTING DRIVE BELT BECAUSE OF BELT AND PULLEY SMALL CONTACT AREA.
6. REPEAT AREAS TO BE TESTED FROM STAGE II OF THE LESSON.
7. DRILL STUDENTS ON KEY POINTS FOR EACH TEST.

SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 278-281
AUTOMOTIVE ENCYCLOPEDIA, PP. 375-380
AUTO SERVICE & REPAIR, PP. 22-29 TO 22-41
AUTOMOTIVE MECHANICS, PP. 357-361

THE NEXT LESSON IS: VIII-A-9(S) "TEST ENGINE VACUUM AND COMPRESSION".

VIII-A-8(J)

# JOB SHEET
# IN
# CHARGING SYSTEM

**JOB:** TEST A. C. TYPE CHARGING SYSTEM

**MATERIALS:** CLEAN RAGS, SOLVENT

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROPLIGHT, BELT TENSION GAUGE, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE, HAND TOOLS, REGULATOR THERMOMETER

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCES. STUDY JOB AND TASK SHEETS. TESTS FOR PARTS OF A. C. CHARGING SYSTEM NOT INCLUDED IN THIS JOB ARE THE SAME AS THE D. C. TYPE CHARGING SYSTEM. REFER TO JOB VIII-A-4(J) FOR THESE TASKS. MAKE SURE THAT THE BATTERY NEGATIVE LEAD IS ALWAYS DISCONNECTED BEFORE HOOKING UP OR REMOVING TEST EQUIPMENT. TOO, THE BATTERY MUST BE FULLY CHARGED BEFORE MAKING TESTS. CHECK WITH THE INSTRUCTOR BEFORE STARTING ENGINE OR USING TEST EQUIPMENT.

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-A-8(TS) | CHECK DRIVE BELT TENSION |
| VIII-A-8a(TS) | FIELD CIRCUIT RESISTANCE TEST |
| VIII-A-8b(TS) | CHARGING CIRCUIT RESISTANCE TEST |
| VIII-A-8c(TS) | ALTERNATOR CURRENT OUTPUT TEST |
| VIII-A-8d(TS) | ELECTRONIC VOLTAGE REGULATOR TEST |
| VIII-A-8e(TS) | ROTOR FIELD COIL DRAW TEST |
| | CLEAN WORK STATION, AS IN PRECEDING TASKS |

TASK SHEET VIII-A-8(TS)

**TASK:** CHECK DRIVE BELT TENSION

**JOB:** TEST A. C. TYPE CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, BELT TENSION GAUGE, PRY BAR, HAND TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS<br>2. RAISE HOOD AND INSTALL FENDER COVERS<br>NOTE: ALTERNATOR DRIVE BELT TENSION IS CRITICAL BECAUSE THE DRIVE PULLEY IS SMALL AND THERE IS LITTLE WRAP AROUND DRIVE BELT ACTION |
| 2. CHECK DRIVE BELT CONDITION | AS IN D. C. GENERATOR BELT INSPECTION |
| 3. ADJUST DRIVE BELT | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT BELT TENSION<br>2. LOOSEN ALTERNATOR SUPPORT BRACKET HINGE BOLTS<br>3. LOOSEN BELT ADJUSTING BRACKET BOLT<br>4. PLACE PRY BAR BETWEEN ENGINE AND HEAVY FRONT SECTION OF ALTERNATOR HOUSING<br>CAUTION: CARE MUST BE TAKEN NOT TO CRUSH THE ALTERNATOR HOUSING WITH THE PRY BAR<br>5. TIGHTEN BELT BY PRYING ALTERNATOR AWAY FROM ENGINE<br>6. HOLD STRAIN ON PRY BAR WITH ONE HAND<br>7. DEPRESS BELT MIDWAY BETWEEN ALTERNATOR PULLEY AND ADJACENT PULLEY WITH OTHER HAND |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: PULL STRAIN ON ALTERNATOR WITH BAR UNTIL THE BELT DEPRESSES APPROXIMATELY ONE-HALF INCH |
| | 8. HOLD STRAIN WITH BAR |
| | 9. TIGHTEN BELT ADJUSTING BRACKET BOLT SECURELY |
| | 10. FIT BELT ADJUSTING GAUGE ON BELT |
| | 11. DEPRESS BELT ADJUSTING GAUGE LEVER |
| | 12. TAKE READING FROM GAUGE DIAL |
| | 13. COMPARE GAUGE READING WITH SPECIFICATIONS |
| | 14. CONTINUE ADJUSTMENT UNTIL PROPER TENSION IS ACQUIRED ON BELT |
| | 15. REMOVE GAUGE AND BAR |
| | 16. TIGHTEN ALTERNATOR SUPPORT BRACKET HINGE BOLTS SECURELY |

TASK SHEET VIII-A-8a(TS)

TASK: FIELD CIRCUIT RESISTANCE TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, FENDER COVERS, SEAT COVERS, DROPLIGHT, VOLTMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP VOLTMETER | 1. REMOVE BATTERY NEGATIVE LEAD CABLE<br>2. REMOVE PRIMARY IGNITION WIRE FROM COIL SIDE OF BALLAST RESISTOR<br>3. CONNECT VOLTMETER NEGATIVE LEAD TO FIELD TERMINAL OF REGULATOR<br>4. CONNECT VOLTMETER POSITIVE LEAD TO POSITIVE POST OF BATTERY<br>5. TURN ALL ACCESSORY SWITCHES AND LIGHT SWITCHES OFF<br>6. CLOSE ALL VEHICLE DOORS |
| 2. TEST FIELD CIRCUIT | 1. CONNECT BATTERY NEGATIVE LEAD BATTERY POST<br>2. TURN ON IGNITION SWITCH<br>NOTE: ENGINE IS NOT TO BE STARTED<br>3. TAKE READING FROM VOLTMETER<br>NOTE: VOLTAGE READING IS NOT TO EXCEED .55 VOLT. ANY READING ABOVE .55 VOLT INDICATES HIGH RESISTANCE IN FIELD CIRCUIT BETWEEN REGULATOR FIELD TERMINAL AND BATTERY |
| 3. TEST FIELD CIRCUIT FOR HIGH RESISTANCE POINT | 1. MOVE VOLTMETER NEGATIVE LEAD TO EACH TERMINAL IN THE FIELD CIRCUIT TO THE BATTERY<br>NOTE: IF THERE IS A SUDDEN DROP IN THE VOLTAGE READING THERE IS A LOOSE OR CORRODED TERMINAL BETWEEN TESTED AND THE PRECEDING TERMINALS |

| STEPS | KEY POINTS |
|---|---|
| | 2. MOVE THE VOLTMETER NEGATIVE LEAD BACK TO THE NEXT TERMINAL<br>3. GRASP THE TERMINAL LEAD CONNECTION OF THE TERMINAL BEING TESTED<br>4. ATTEMPT TO MOVE THE TERMINAL LEAD CONNECTION FROM SIDE TO SIDE<br>5. WATCH THE VOLTMETER<br>NOTE: ANY MOVEMENT OF THE VOLTMETER NEEDLE INDICATES A LOOSE TERMINAL OR IT IS MAKING PARTIAL CONTACT THROUGH THE CORROSION<br>6. TIGHTEN OR CLEAN THE TERMINAL |
| 4. REMOVE TEST EQUIPMENT | 1. TURN OFF IGNITION<br>2. REMOVE BATTERY NEGATIVE TERMINAL LEAD<br>3. DISCONNECT VOLTMETER<br>4. CONNECT IGNITION PRIMARY LEAD TO BALLAST RESISTOR TERMINAL<br>5. CONNECT BATTERY NEGATIVE LEAD TO NEGATIVE BATTERY POST |

## TASK SHEET

VIII-A-8b(TS)

TASK: CHARGING CIRCUIT RESISTANCE TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVER, SEAT COVER, DROPLIGHT, HAND TOOLS, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE SWITCH

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TEST EQUIPMENT | 1. DISCONNECT BATTERY NEGATIVE TERMINAL LEAD |
| | 2. REMOVE "BAT" LEAD FROM ALTERNATOR OUTPUT TERMINAL |
| | 3. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND DISCONNECTED "BAT" LEAD |
| | 4. CONNECT VOLTMETER POSITIVE LEAD TO "BAT" LEAD WITH VOLTMETER LEAD |
| | 5. CONNECT VOLTMETER NEGATIVE LEAD TO BATTERY POSITIVE POST |
| | 6. DISCONNECT FIELD LEAD FROM ALTERNATOR TO VOLTAGE REGULATOR AT ALTERNATOR |
| | 7. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL WHERE THE LEAD HAS BEEN REMOVED |
| | 8. CONNECT OPPOSITE END OF JUMPER LEAD TO A GOOD GROUND |
| | 9. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY IGNITION LEAD AND A GOOD GROUND |
| | 10. TURN CARBON PILE SWITCH TO OFF POSITION |
| | 11. CONNECT CARBON PILE BETWEEN BATTERY TERMINALS |
| 2. PERFORM CHARGING CIRCUIT RESISTANCE TEST | 1. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| | 2. START ENGINE |
| | 3. RUN ENGINE AT IDLE SPEED |

| STEPS | KEY POINTS |
|---|---|
| | 4. ADJUST ENGINE RPM AND CARBON PILE SWITCH TO MAINTAIN 20 AMPERE FLOW IN CHARGING SYSTEM |
| | 5. OBSERVE VOLTMETER |
| | NOTE: VOLTMETER READING IS NOT TO EXCEED .7 VOLT. IF VOLTMETER READING IS ABOVE .7 VOLT INSPECT, CLEAN, AND TIGHTEN ALL CHARGING CIRCUIT CONNECTIONS |
| | 6. PERFORM VOLTAGE DROP TEST AT EACH TERMINAL TO LOCATE TERMINAL WITH EXCESSIVE RESISTANCE |
| 3. REMOVE TEST EQUIPMENT | 1. RESET ENGINE IDLE RPM ACCORDING TO SPECIFICATIONS |
| | 2. TURN OFF CARBON PILE SWITCH |
| | 3. STOP ENGINE |
| | 4. DISCONNECT BATTERY NEGATIVE LEAD |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. CONNECT FIELD LEAD TO ALTERNATOR FIELD TERMINAL |
| | 7. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

TASK SHEET VIII-A-8c(TS)

TASK: ALTERNATOR CURRENT OUTPUT TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| | NOTE: TEST IS PERFORMED TO DETERMINE WHETHER OR NOT ALTERNATOR WILL DELIVER ITS RATED CURRENT OUTPUT |
| 1. HOOK UP TEST EQUIPMENT | 1. DISCONNECT BATTERY NEGATIVE LEAD<br>2. REMOVE "BAT" LEAD AT ALTERNATOR OUTPUT TERMINAL<br>3. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND DISCONNECTED "BAT" LEAD<br>4. CONNECT VOLTMETER POSITIVE LEAD TO ALTERNATOR "BAT" TERMINAL<br>5. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND<br>6. REMOVE ALTERNATOR TO VOLTAGE REGULATOR FIELD LEAD AT ALTERNATOR<br>7. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL WHERE LEAD HAS BEEN REMOVED<br>8. CONNECT SECOND END OF JUMPER TO GOOD GROUND<br>9. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY IGNITION LEAD AND GOOD GROUND<br>10. TURN CARBON PILE SWITCH TO OFF<br>11. CONNECT CARBON PILE BETWEEN BATTERY POSTS |
| 2. PERFORM ALTERNATOR CURRENT OUTPUT TEST | 1. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

| STEPS | KEY POINTS |
|---|---|
| | 2. START ENGINE AND RUN AT IDLE RPM<br>3. GRADUALLY INCREASE ENGINE SPEED TO 1250 RPM<br>4. ADJUST CARBON PILE UNTIL VOLTMETER READING IS 15 VOLTS<br>CAUTION: VOLTMETER IS NOT TO REACH A READING ABOVE 16 VOLTS<br>5. CHECK MANUFACTURER'S SPECIFICATIONS FOR ALTERNATOR OUTPUT LIMITS<br>NOTE: IF AMMETER READING IS LESS THAN SPECIFIED LIMITS ALTERNATOR SHOULD BE REMOVED FROM THE VEHICLE AND BENCH TESTED |
| 3. REMOVE TEST EQUIPMENT | 1. TURN OFF CARBON PILE SWITCH<br>2. ADJUST ENGINE IDLE RPM<br>3. STOP ENGINE<br>4. REMOVE BATTERY NEGATIVE LEAD<br>5. REMOVE TEST EQUIPMENT<br>6. CONNECT "BAT" LEAD TO ALTERNATOR "BAT" TERMINAL<br>7. CONNECT FIELD LEAD TO ALTERNATOR FIELD TERMINAL<br>8. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

TASK SHEET VIII-A-8d(TS)

TASK: ELECTRONIC VOLTAGE REGULATOR TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS, VOLTMETER, TACHOMETER, REGULATOR, THERMOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TEST EQUIPMENT | 1. REMOVE BATTERY TERMINAL LEADS<br>2. THOROUGHLY CLEAN BATTERY POSTS AND TERMINAL CONNECTORS<br>3. CONNECT VOLTMETER POSITIVE LEAD TO IGNITION NUMBER ONE TERMINAL AT BALLAST RESISTOR<br>4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND<br>5. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY IGNITION LEAD AND GOOD GROUND<br>6. CONNECT REGULATOR THERMOMETER TO REGULATOR |
| 2. PERFORM ELECTRONIC VOLTAGE REGULATOR TEST | 1. CONNECT BATTERY POSITIVE LEAD TO BATTERY POSITIVE POST<br>2. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST<br>3. START ENGINE<br>4. SET ENGINE SPEED AT 1250<br>NOTE: NO LIGHTS OR ACCESSORIES ARE TO BE ON AND THE VEHICLE DOORS ARE TO BE CLOSED<br>5. CHECK MANUFACTURER'S SPECIFICATIONS FOR AMBIENT AIR TEMPERATURE AND CORRESPONDING VOLTAGE READING LIMITS<br>6. ALLOW REGULATOR TO WARM UP TO OPERATING TEMPERATURE<br>7. TAKE READING FROM VOLTMETER<br>8. TAKE READING FROM REGULATOR THERMOMETER |

| STEPS | KEY POINTS |
|---|---|
| | 9. COMPARE AMBIENT AIR TEMPERATURE TO VOLTMETER READING |
| A. VOLTAGE READING BELOW SPECIFICATIONS TEST | 1. STOP ENGINE<br>2. PERFORM REGULATOR GROUND TEST, USE TASK SHEET VIII-A-7g(TS)<br>3. REMOVE BATTERY NEGATIVE LEAD<br>4. DISCONNECT REGULATOR CONNECTOR<br>5. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST<br>6. TURN ON IGNITION SWITCH<br>NOTE: ENGINE IS NOT TO BE STARTED<br>7. CHECK FOR BATTERY VOLTAGE IN WIRING HARNESS<br>a. USE VOLTMETER<br>b. PROBE BOTH WIRING HARNESS TERMINALS<br>NOTE: NO VOLTAGE AT EITHER LEAD<br>a. PROBLEM IS IN VEHICLE WIRING "OR"<br>b. PROBLEM IS IN ALTERNATOR FIELD CIRCUIT<br>NOTE: VOLTAGE PRESENT AT BOTH LEADS, REPLACE REGULATOR<br>8. DISCONNECT BATTERY NEGATIVE LEAD<br>9. CONNECT REGULATOR CONNECTOR TO REGULATOR<br>10. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| B. VOLTAGE READING HIGHER THAN SPECIFICATIONS TEST | 1. PERFORM REGULATOR GROUND TEST, USE TASK SHEET VIII-A-7g(TS)<br>2. PERFORM CHARGING SYSTEM GROUND TEST, USE TASK SHEET VIII-A-7g(TS)<br>NOTE: SYSTEM AND REGULATOR HAVE PROPER GROUND, PROBLEM IS INTERNAL AND REGULATOR MUST BE REPLACED<br>NOTE: ALL OTHER REGULATOR TESTS ARE MADE THE SAME AS THE D. C. CHARGING SYSTEM. USE JOB SHEET |

| STEPS | KEY POINTS |
|---|---|
| | VIII-A-4(J) |
| 3. REMOVE TEST EQUIPMENT | 1. START ENGINE<br>2. ADJUST ENGINE SPEED TO IDLE RPM<br>3. STOP ENGINE<br>4. DISCONNECT BATTERY NEGATIVE LEAD<br>5. REMOVE TEST EQUIPMENT<br>6. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

## TASK SHEET

TASK: ROTOR FIELD COIL DRAW TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS, BATTERY TESTER, AMMETER, JUMPER LEAD, BELT ADJUSTING GAUGE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. TEST BATTERY | 1. FOR FULL CHARGE<br>2. REMOVE BATTERY NEGATIVE LEAD<br>3. REMOVE BATTERY POSITIVE LEAD<br>4. PERFORM BATTERY CHARGE TEST, USE TASK SHEET VIII-A- d(TS)<br>5. CHARGE BATTERY IF NECESSARY |
| 2. HOOK UP TEST EQUIPMENT | 1. LOOSEN ALTERNATOR DRIVE BELT, USE TASK SHEET VIII-A-5(TS)<br>2. MARK AND REMOVE LEADS FROM ALTERNATOR<br>3. CONNECT JUMPER LEAD BETWEEN ONE ALTERNATOR FIELD TERMINAL AND BATTERY POSITIVE POST<br>4. CONNECT AMMETER POSITIVE LEAD TO ALTERNATOR SECOND FIELD TERMINAL<br>5. CONNECT AMMETER NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| 3. PERFORM ROTOR FIELD COIL DRAW TEST | 1. SLOWLY ROTATE ALTERNATOR PULLEY BY HAND<br>2. OBSERVE AMMETER READING<br>NOTE: AMMETER READING SHOULD INDICATE FIELD COIL DRAW BETWEEN 2.5 AND 3.1 AMPERES<br>LOW AMMETER READING - THERE IS HIGH RESISTANCE IN ROTOR, SLIP RINGS, OR BRUSHES<br>HIGH AMMETER READING - THE ROTOR IS SHORTED OR GROUNDED<br>NO AMMETER READING - THERE IS AN OPEN IN THE ROTOR OR THE BRUSHES ARE DEFECTIVE |

| STEPS | KEY POINTS |
|---|---|
| 4. REMOVE TEST EQUIPMENT | 1. REMOVE JUMPER LEAD AND AMMETER<br>2. CONNECT ALL ALTERNATOR LEADS TO PROPER TERMINALS AS MARKED<br>3. ADJUST ALTERNATOR DRIVE BELT, USE TASK SHEET VIII-A-5(TS)<br>4. CONNECT BATTERY LEADS, POSITIVE FIRST AND NEGATIVE LAST |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

# INFORMATION SHEET
# ON
# ENGINE TROUBLE DIAGNOSIS

SUBJECT: Pressure Gauges

## INTRODUCTORY INFORMATION:

Measuring devices of one kind or another have been used since the beginning of time and will continue to be used until the end of time.

The caveman judged distances by eye or by time. He compared sizes by paces or by matching objects with trees, stones, or other objects that he knew from memory. He knew temperature was cold, warm, or hot only by touch. His body literally became his own yardstick, or measuring device. Seeing that his basic needs required no degree of accuracy, his arms, legs, feet, hands, and fingers were used to measure his clothing, weapons, and other necessities. He worked alone and had his own methods for measuring, and consequently no standards were ever set.

The caveman was not faced with the need for the close tolerances and the precision required on the thousands of parts found in the modern automobile. In mass production industries, where items are made by the millions, measurements have to be within the design tolerances. No guesswork is allowed. The service technician in the automotive shop must also work with exact measurements. To do this he must use precision measuring devices while performing his daily job.

While we must still continue to use our senses for rough approximation in certain situations and will find them helpful in diagnosis of trouble, greater and greater precision in modern automobiles has led to a need for precise measuring devices and the ability to use them correctly.

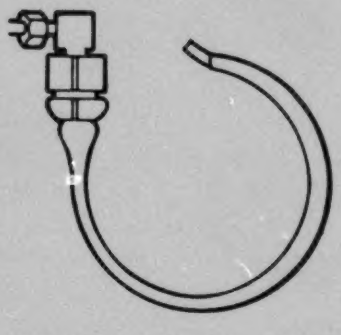
## GENERAL INFORMATION

Several different kinds of pressure gauges for measuring air and gas, liquids, and vacuums are in use today, such as the dial-type pressure gauge and stem-type tire pressure gauge.

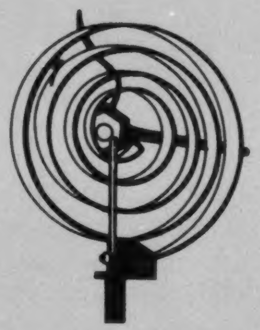
The stem-type tire pressure gauge consists basically of a springloaded plunger and a measuring rod scaled off in pounds per square inch of pressure.

Bourdon tube - Dial-type pressure gauges are used on various pieces of shop equipment, such as oxygen and acetylene tanks, engine-cylinder compression gauges, air-conditioning charging stations, air compressors and many others. There are several different types of dial-type pressure gauges currently available, but the type most commonly used is the Bourdon tube gauge.

Basically, the Bourdon tube gauge consists of a curved, hollow tube connected to a pointer through a lever and gear mechanism. When the pressure in the system being checked enters the Bourdon gauge, it also enters the curved, hollow tube. As the pressure increases, the curved, hollow tube tends to straighten. The tube is connected to a lever and gear mechanism and cannot straighten but moves slightly and pulls the lever. Movement of the lever turns a sector, and the sector rotates a small gear. As the small gear is rotated, it moves the needle on the dial to indicate the amount of pressure in the system. Most Bourdon tube gauges are calibrated in pounds per square inch.

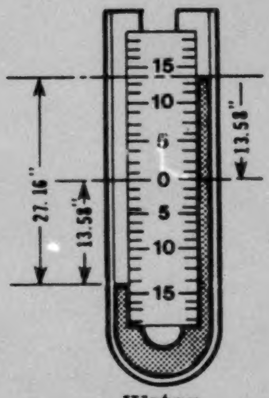


C-shaped Bourdon tube



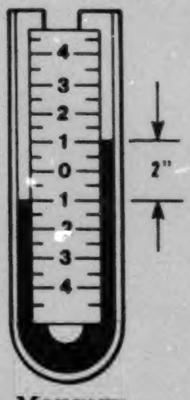
Spiral Bourdon tube

Manometer - A more accurate means of measuring air pressures in the automotive shop is with the use of the manometer. The manometer is the simplest device for measuring pressure, and the simplest form of the manometer is the U-tube. This consists of a glass or plastic tube shaped like the letter U and a scale marked in inches and tenths of inches with the zero mark in the center. When the air-pressure line is connected to the manometer, the liquid is pushed downward in one arm of the tube and upward in the other arm. The amount of pressure being measured is then shown by the difference in height of the liquid in the two columns.



Water

Difference in height of liquid in columns



Mercury

The open-tube manometer, containing water, is used for measuring low air pressures. If mercury is substituted for the water, higher pressures can be measured without having so long a tube. For example, if a pressure line connected to a manometer containing mercury lowers the fluid one inch in one column and raises it one inch in the other, the inlet line pressure is expressed as two inches-of-mercury or 0.98 pounds per square inch.

If water is used as the manometric fluid, the same pressure would cause the water to be lowered 13.58 inches in one column and raised 13.58 inches in the other. The pressure would then be expressed as 27.16 inches-of-water.

For still higher pressures, the closed-tube manometer, containing mercury, is used. In the closed-tube-type manometer, the air is compressed in the sealed end of the tube, permitting a much higher pressure reading. A scale may be used with either type manometer. This may be calibrated in either inches of mercury, inches of water, or in pounds per square inch.

Most pressure gauges used in the automotive shop measure only the pressure above atmospheric. Therefore, they read zero at atmospheric pressure. To obtain the true or absolute pressure, the local atmospheric pressure - - which is dependent upon the elevation of the area - - must be added to the gauge pressure. This atmospheric pressure is 14.7 pounds per square inch at sea level. However, some gauges are designed to indicate pressures lower than atmospheric pressure. This type gauge is called a vacuum gauge. Vacuum-gauge dials are marked in inches of mercury to correspond with the "U"-tube manometer used in the laboratories during calibration.

Vacuum gauges, when used properly, will provide considerable useful information about the interior condition of the automobile engine. However, it is easy to misinterpret the reading of the vacuum gauge, and in doing so, a false conclusion regarding the trouble will result.

A vacuum gauge can be used to check for such things as ignition timing, carburetor adjustments, improper valve action, cylinder leakage, and many others. In using a vacuum gauge on an engine, it is very important to note the action of the gauge needle, more so than how much vacuum can be obtained.

Usually, if the engine is in good internal condition and properly adjusted, the vacuum gauge needle will hold steady at a reading of between 17 and 21 inches of mercury at idle speed. There will be, of course, some variation to this rule with changes in altitude and atmospheric conditions. As an example, an eight-cylinder engine will ordinarily have a reading slightly higher than a six-cylinder engine; and a six-cylinder engine, slightly higher than a four-cylinder. Also, for every 1,000 feet above sea level, the reading on the vacuum gauge will be lowered approximately one inch.

Before using the vacuum gauge, it is extremely important to read the manufacturer's instructions and be thoroughly familiar with the vacuum-gauge operation.

# INFORMATION SHEET
# ON
# ENGINE TROUBLE DIAGNOSIS

SUBJECT: Cylinder Compression and Manifold Vacuum Tests

INTRODUCTORY INFORMATION:

As manufacturers continue to improve engine design, engines have decreased greatly in size, yet increased in power output. This calls for closer clearances, finer fits, and more accurate adjustments for the maintenance of satisfactory engine performance.

Fine adjustments necessary for peak running condition are obviously futile if the engine has major internal defects. Therefore, one of the first checks made is to detect evidence of leaking piston rings, faulty valves or valve timing, leaking or loose bearings, or worn camshaft lobes.

## GENERAL INFORMATION

One of the first steps of engine tune-up is to make sure each cylinder has compression pressure within the range specified by the engine manufacturer. It is also important to note pressure variation between cylinders, as this variance will have a more adverse effect upon engine performance than overall readings of slightly below specifications. Cylinders with readings within ten pounds of each other are not likely to be noticeable in the performance of the engine. If the pressure variation exceeds ten pounds above normal, the heads should be removed and the carbon scraped from all surfaces of the combustion chamber. The problem in this case is a reduction of volume in the combustion chamber resulting from carbon buildup.

Readings below normal indicate loss of compression past the valves, piston rings, or through a leaking gasket. If pressure is increased after placing a small amount of oil in cylinders having low readings, the problem is probably with worn piston rings. If readings remain steady and low, the problem is likely a loss of pressure past the valves. In either case, an abnormal loss of compression requires the removal of cylinder heads to make an accurate diagnosis.

Intake Manifold Vacuum. The vacuum gauge is another very important engine tester. In the hands of an experienced operator, it can provide considerable useful information about the condition of internal parts of the engine. Vacuum tests are made and the readings used in three different ways: as a preliminary test before any corrections are made, as a final test to prove the effectiveness of corrections, and to adjust the carburetor. When properly used and understood, the vacuum gauge will indicate the following defects:

Improper valve action
Restricted exhaust system

Cylinder leakage
Intake system leakage
Ignition timing
Ignition defects
Incorrect carburetor adjustment

The vacuum gauge is usually connected to the intake manifold at the windshield wiper connection. The needle indicator is then closely observed while the engine runs at idle speed. Normal vacuum reading is between 17 and 20. The following interpretations apply to most engines.

Normal and steady -- a fair indication that little of anything is wrong with engine operation at that particular speed and load condition.

Low and steady -- indicates a power reduction caused by late ignition or valve timing, or a loss of compression.

Very low -- intake manifold, carburetor spacer or head gasket leak.

Oscillations of the needle, increasing with engine speed -- partial or complete loss of power in one or more cylinders caused by a leaky head or manifold gasket, burnt valve, weak valve spring, or a defect in the ignition system.

Gradual drop in reading at idle speed -- excessive back pressure in exhaust system, generally caused by clogged line.

Intermittent fluctuation -- defect in ignition system or sticking valve.

Slow fluctuation or drifting of the needle -- excessively rich air-fuel mixture or restricted crankcase ventilation system.

VIII-A-9(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** TEST ENGINE VACUUM AND COMPRESSION

**AIM:**

1. THE STUDENT WILL BE ABLE TO VACUUM TEST THE ENGINE FOLLOWING THE PROPER PROCEDURES AND WILL ALSO BE ABLE TO DETERMINE THE EFFECTIVENESS OF THE VEHICLE'S VACUUM ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS.
2. THE STUDENT WILL BE ABLE TO TEST THE ENGINE'S COMPRESSION WITH THE PROPER EQUIPMENT AND DETERMINE THE EFFECTIVENESS OF THE RINGS AND VALVES.

**TOOLS AND EQUIPMENT:** VACUUM GAUGE, COMPRESSION GAUGE, SPARK PLUG WRENCH, SENDING UNIT ADAPTER, SOCKET, SPEED HANDLE, TABLESPOON

**MATERIALS:** MOTOR OIL, CLEAN RAGS

**TEACHING AIDS:**

**REFERENCES:**
AUTOMOTIVE ENCYCLOPEDIA, PP. 49-56, 173-186
AUTO SERVICE AND REPAIR, CH. 23
AUTOMOTIVE MECHANICS, CHS. 3 AND 4

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST KNOW THE PRINCIPLES OF ENGINE OPERATION INCLUDING THE FOUR STROKE CYCLE, COMPRESSION RATIOS, AND CUBIC INCHES DISPLACEMENT.

THE STUDENT MUST ALSO KNOW WHAT A VACUUM GAUGE AND A COMPRESSION GAUGE ARE AND BE FAMILIAR WITH THEIR BASIC FUNDAMENTALS OF OPERATION.

**CHECKING STANDARDS:**

1. PROPER USE OF THE VACUUM GAUGE.
2. PROPER IDENTIFICATION AND DIAGNOSIS OF MECHANICAL DEFICIENCIES DUE TO LACK OF VACUUM.
3. PROPER USE OF THE COMPRESSION GAUGE.
4. PROPER IDENTIFICATION AND DIAGNOSIS OF MECHANICAL DEFICIENCIES DUE TO LACK OF COMPRESSION.

---

## I. PREPARATION (OF THE LEARNER)

1. THE GAUGES IN THIS LESSON ARE MECHANICAL DEVICES DESIGNED TO MEASURE THE ENGINE'S EFFICIENCY.
2. THE REASON FOR TESTING THE ENGINE'S EFFICIENCY IN THIS MANNER IS THAT IT IS FIRST OF ALL A SIMPLE PROCEDURE, AND IT ALSO DISCLOSES ANY PROBLEMS THAT MAY BE PRESENT IN TIMING VACUUM ADVANCE OR

## I. PREPARATION (CON'T.)

IN RING AND VALVE WEAR AND CLEARANCE.

3. THE TEST WILL BE ON THE CORRECT WAY TO INSTALL THE VACUUM GAUGE AND THE COMPRESSION GAUGE AND THE CORRECT ANALYSIS OF THE INFORMATION OBTAINED. ALSO INCLUDED WILL BE THE CORRECT PROCEDURE TO FOLLOW AS TO SAFETY PRECAUTIONS AND SAFETY RULES.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. DEMONSTRATE | 1. PERFORM ALL TASKS<br>2. MAKE ALL KEY POINTS CLEAR AND PRECISE<br>3. EMPHASIZE SAFETY |
| 2. POSITION VEHICLE | 1. PLACE VEHICLE IN STALL<br>2. PROPERLY ALIGNED<br>3. SET FOOT OR HAND BRAKE<br>4. STOP ENGINE<br>5. OPEN HOOD |
| 3. WARM ENGINE | 1. SET HAND BRAKE<br>2. PLACE IN NEUTRAL OR PARK<br>3. START ENGINE<br>4. ENGINE IS TO BE WARMED TO OPERATING TEMPERATURE<br>5. TURN ENGINE OFF<br>6. CHECK OIL<br>a. OIL SHOULD BE PROPER GRADE<br>b. CLEAN |
| 4. REMOVE SPARK PLUGS | 1. REMOVE SPARK PLUG CABLES<br>a. HOLD CABLE AT BOOT<br>b. PULL CABLE AT BOOT<br>2. CLEAN AROUND PLUGS<br>a. USE A CLEAN RAG<br>b. WIPE DIRT AND GRIME FROM PLUG<br>c. DO NOT PERMIT DIRT TO ENTER CYLINDER<br>3. REMOVE ALL SPARK PLUGS<br>a. USE SPARK PLUG SOCKET AND RATCHET<br>b. BE CAREFUL NOT TO BREAK PLUGS |

| | |
|---|---|
| | c. LABEL PLUG AS TO CYLINDER REMOVED FROM TO INDICATE PROBLEM CYLINDER |
| 5. OPEN CHOKE AND THROTTLE VALVES | 1. REMOVE RETURN SPRING<br>a. DISCONNECT THROTTLE LINKAGE<br>b. DISCONNECT AUTOMATIC CHOKE<br>NOTE: BOTH VALVES MUST BE WIDE OPEN<br>2. BLOCK OPEN IF NECESSARY |
| 6. USE A REMOTE STARTER SWITCH | 1. INSTALL STARTER SWITCH<br>a. ATTACH ONE LEAD TO STORAGE BATTERY POSITIVE TERMINAL<br>b. ATTACH ONE LEAD TO STARTER SOLENOID<br>c. STAND TO SIDE OF FENDER<br>d. WEAR SAFETY GOGGLES<br>2. LAY STARTER SWITCH ON A FLAT SURFACE ACCESSIBLE TO EASY REACH |
| 7. USE COMPRESSION GAUGE | 1. PLACE COMPRESSION GAUGE IN NUMBER ONE CYLINDER<br>a. HOLD IN CYLINDER FIRMLY<br>b. MUST HAVE A GOOD SEAL AROUND RUBBER FITTING<br>c. HOLD WITH ENOUGH PRESSURE TO PREVENT BLOW-BY<br>2. TURN ENGINE OVER AT LEAST FOUR TIMES<br>a. USE STARTER SWITCH<br>b. WATCH COMPRESSION GAUGE<br>3. RECORD THE HIGHEST READING OBTAINED<br>4. PROCEED TO THE FOLLOWING CYLINDERS<br>a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS<br>b. WRITE DOWN HIGHEST COMPRESSION INDICATIONS FOR EACH RESPECTIVE CYLINDER<br>5. COMPRESSION IS TO BE BETWEEN 130 AND 170 PSI. AND A MAXIMUM VARIATION BETWEEN CYLINDERS OF 20 PSI. |

8. COMPARE COMPRESSION SCORE
    1. USE COMPRESSION PRESSURE LIMIT CHART FOR TYPICAL VEHICLE TESTING
    2. ACCORDING TO TESTS AND CHART READINGS DECIDE IF THE ENGINE CAN BE CORRECTED BY TUNE-UP
        a. VARIANCES OF MORE THAN PRESCRIBED RANGE INDICATES THAT THE CYLINDERS, RINGS, OR VALVES - OR ALL THREE - ARE DEFECTIVE
        b. USE OIL TEST

9. OIL CYLINDERS
    1. TEST FOR RING AND VALVE SEATING
        a. PUT ONE TABLESPOON OF OIL IN EACH CYLINDER
        b. INSERT COMPRESSION GAUGE
    2. TURN ENGINE AT LEAST FOUR TIMES
        a. THE SAME PRESSURE AS BEFORE MEANS VALVES ARE BURNT AND ARE NOT SEATING
        b. INCREASE IN PRESSURE MEANS THE OIL HAS HELPED THE RINGS TO SEAL AND THE RINGS ARE WORN PAST EFFECTIVENESS, THE CYLINDER IS CONE SHAPED, OR BROKEN PISTON
    3. PROCEED TO THE FOLLOWING CYLINDERS
        a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS
        b. WRITE DOWN HIGHEST COMPRESSION INDICATION FOR EACH RESPECTIVE CYLINDER
        c. TWO WEAK CYLINDERS ADJACENT MIGHT INDICATE A "BLOWN" CYLINDER HEAD GASKET
    4. REPLACE SPARK PLUGS
        a. USE SPARK PLUG WRENCH
        b. BE CAREFUL NOT TO CROSS THE THREADS

USE A VACUUM GAUGE

1. WARM THE ENGINE
    1. ENGINE TO BE WARMED TO OPERATING TEMPERATURE

2. RUN ENGINE AT SLIGHTLY HIGHER THAN IDLING SPEED
3. TURN ENGINE OFF

2. ATTACH VACUUM GAUGE
    1. ATTACH TO THE INTAKE MANIFOLD
        a. ATTACH TO THE INLET PIPE ON THE INTAKE MANIFOLD - USE AN ADAPTER
        b. AVOID LEAKS IN THE WINDSHIELD WIPER OR CONNECTIONS
    2. ATTACH TO ANY VACUUM HOSE IF NECESSARY

3. MAKE CRANKING TEST
    1. BACK OFF THE IDLE SPEED SCREW TO ALLOW THE THROTTLE VALVE TO FULLY CLOSE
    2. GROUND THE COIL HIGH TENSION WIRE
    3. CRANK ENGINE AND AVERAGE READINGS
        a. RELATIVELY STEADY, HIGH VACUUM INDICATES AN ABSENCE OF VACUUM LEADS AND GOOD RING AND VALVE ACTION
        b. LOW, BUT FAIRLY STEADY READING CAN MEAN VACUUM LEAKS, WORN VALVE GUIDES, POOR COMPRESSION, VALVE TIMING OFF
        c. AN ERRATIC READING CAN POINT TO BURNED OR STICKY VALVES, DAMAGED PISTON, BLOWN GASKET
    4. READJUST IDLESCREW
        a. USE APPROPRIATE TOOL
        b. FOLLOW MANUFACTURER'S SPECIFICATIONS FOR IDLE SPEED
    5. REATTACH COIL SECONDARY WIRE TO DISTRIBUTION

4. MAKE VACUUM TEST - ENGINE RUNNING
    1. CORRECT RESPONSE:
        a. NEEDLE WILL BE STEADY AT BETWEEN 17-21 WHEN IDLING
        b. SUDDENLY OPEN AND CLOSE THE THROTTLE
        c. NEEDLE WILL DROP TO BELOW 5, THEN BOUNCE UP TO AROUND 25

NOTE: SUBTRACT ONE INCH FROM THE SPECIFIED READING FOR EVERY 1,000 FEET OF ELEVATION ABOVE SEA LEVEL

2. LEAKING RINGS:
   a. FAIRLY STEADY NEEDLE
   b. 3-4 POINTS LOWER THAN NORMAL
   c. SUDDEN OPEN AND CLOSING OF THROTTLE NEEDLE MAY SINK TO ZERO THEN BOUNCE TO ABOUT 22
3. SLOW TIMING:
   a. GOOD COMPRESSION
   b. LOW NEEDLE READING
   c. A CONSIDERABLE LOW NEEDLE READING MEANS THE VALVE TIMING MAY BE SLOW
   d. CARBURETOR ADJUSTMENT WILL NOT CHANGE VACUUM TO NORMAL --MAKE A CHECK TO SEE IF EITHER OR BOTH IGNITION OR VALVE TIMING SHOULD BE ADVANCED
4. LEAKING INTAKE:
   a. STEADY NEEDLE
   b. 3-9 POINTS LOW
   c. THROTTLE VALVE IS NOT CLOSING
   d. AIR LEAK EXISTS IN CARBURETOR OR INTAKE MANIFOLD OR GASKETS
5. LEAKING CYLINDER HEAD GASKET:
   a. FLOATING NEEDLE BETWEEN LOW AND HIGH READING
   b. CYLINDER HEAD GASKET BLOWN BETWEEN TWO ADJACENT CYLINDERS
6. CARBURETOR OUT OF ADJUSTMENT:
   a. NEEDLE FLOATS SLOWLY
   b. RANGE OF 4-5 POINTS
7. SPARK PLUG GAPS:
   a. NEEDLE FLOATS SLOWLY OVER A NARROWER RANGE - 2 POINTS
   b. SPARK PLUG GAP PROBABLY TOO CLOSE
   c. IGNITION POINTS MAY NOT BE OPERATING PROPERLY

8. RESTRICTED EXHAUST:
   - a. NEEDLE READS NORMAL RANGE UPON STARTING
   - b. SINKS TO ZERO
   - c. THEN RISES SLOWLY TO BELOW NORMAL
   - d. CLOGGED PIPE

9. DEFECTIVE VALVE ACTION
   - a. LEAKING, BURNED, STICKING VALVES, WEAK VALVE SPRINGS, OR WORN GUIDES
   - b. ACTION OF THE NEEDLE AND RANGE OF THE MOTION ARE INDICATORS OF FAULT

10. ENGINE MECHANICAL CONDITION
   - a. INDICATION OF LOSS OF COMPRESSION OR IMPROPER VALVE ACTION, TUNE-UP WILL DO NO GOOD, THESE MECHANICAL FAULTS MUST BE CORRECTED
   - b. INDICATION OF TIMING ERRORS, INTAKE LEAKS, CARBURETOR OUT OF ADJUSTMENT, OR RESTRICTED EXHAUST SYSTEM, CORRECT THESE DEFECTS AS THE NEXT STEP

5. REMOVE VACUUM GAUGE
   1. REMOVE VACUUM GAUGE FROM INTAKE MANIFOLD
   2. BE SURE TO REPLACE ANY VACUUM HOSES

6. CHECK ENGINE OPERATION
   1. LISTEN FOR
      - a. ROUGH IDLE
      - b. ENGINE NOISES
      - c. VIBRATION
   2. STOP ENGINE
   3. REMOVE OIL PRESSURE GAUGE
   4. REPLACE SENDING UNIT

7. CLEAN WORK STATION
   1. MAKE FINAL INSPECTION UNDER HOOD
   2. CLOSE HOOD
   3. REMOVE CAR TO SAFE PLACE
   4. APPLY SORB-ALL TO OILY SPOTS
   5. WIPE VEHICLE CLEAN OF FINGER PRINTS
   6. BRUSH OFF WORK BENCHES

7. SWEEP FLOOR
8. COUNT TOOLS
9. CHECK IN TOOLS

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS PRACTICE ON THEIR OWN USING JOB AND TASK SHEETS VIII-A-8(J) UNDER SUPERVISION OF THE INSTRUCTOR.
2. OBSERVE AND RETEACH, IF THE NEED ARISES, THE USE OF THE COMPRESSION AND VACUUM GAUGE.
3. CHECK STUDENTS FOR KEY POINTS.
4. STUDENTS TO PRACTICE ON TASK.
5. HAVE STUDENTS DO MANIPULATIVE TASK AND GIVE KEY POINTS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP FROM STAGE II.
2. REEMPHASIZE THE KEY POINTS IN STAGE II.
3. REPEAT THE DIFFERENT MALFUNCTIONS DETECTABLE BY THE COMPRESSION GAUGE AND VACUUM GAUGE.

SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, CH. 1
AUTOMOTIVE ENCYCLOPEDIA, PP. 7-23
AUTO SERVICE AND REPAIR, CHS. 1, 2, 3
AUTOMOTIVE MECHANICS, CH. 2

THE NEXT LESSON IS: VIII-A-10(S) "PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM"

VIII-A-9(J)

# JOB SHEET
IN
ENGINE OPERATION AND DESIGN

| | | |
|---|---|---|
| JOB: | TEST ENGINE VACUUM AND COMPRESSION | |
| MATERIALS: | CLEAN RAGS, ENGINE OIL | |
| TOOLS AND EQUIPMENT: | OPEN END WRENCH, VACUUM GAUGE, COMPRESSION GAUGE, SPARK PLUG WRENCH, TABLESPOON | |
| GENERAL INSTRUCTIONS: | BEFORE DOING THIS JOB IT WILL BE ADVISABLE TO DO THE NECESSARY READING IN THE REFERENCES RELATED TO THIS JOB. ALSO, STUDY PREVIOUS INFORMATION SHEETS ON USING THE OIL PRESSURE GAUGE. | |
| PROCEDURES AND/OR TASKS: | VIII-A-1(TS) | PREPARE VEHICLE - (EXCEPT DISCONNECT STORAGE BATTERY) |
| | VIII-A-9(TS) | USE COMPRESSION GAUGE |
| | VIII-A-9a(TS) | USE VACUUM GAUGE |
| CHECK POINT: | BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK. | |
| | CLEAN WORK STATION AS IN PREVIOUS TASK. | |

## TASK SHEET

VIII-A-9 (TS)

**TASK:** USE COMPRESSION GAUGE

**JOB:** TEST ENGINE VACUUM AND COMPRESSION

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** COMPRESSION GAUGE, MOTOR OIL, CLEAN RAGS, SPARK PLUG WRENCH

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE SPARK PLUGS | 1. REMOVE SPARK PLUG CABLES<br>a. HOLD CABLE ON BOOT<br>b. PULL CABLE ON BOOT<br>CAUTION: PULLING ON CABLE WILL SEPARATE THE WIRE IN THE CABLE<br>2. MARK SPARK PLUG WIRES AS THEY ARE REMOVED<br>a. USE MASKING TAPE<br>b. INDICATE CYLINDER NUMBER AS IT IS REMOVED<br>3. CLEAN AROUND PLUGS<br>a. USE A CLEAN RAG<br>b. WIPE DIRT AND GRIME FROM PLUG<br>c. DO NOT PERMIT DIRT TO ENTER CYLINDER<br>4. USE RUBBER LINED SPARK PLUG SOCKET AND RATCHET<br>5. TURN TO THE LEFT ONE TURN<br>CAUTION: BE CAREFUL NOT TO SLIP AND BREAK THE PLUG INSULATOR<br>6. MARK EACH PLUG AS TO CYLINDER<br>NOTE: PLUG DAMAGE CAN BE RELATED TO CYLINDER CONDITION |
| 2. OPEN CHOKE AND THROTTLE VALVES OF CARBURETOR | 1. REMOVE THE AIR CLEANER<br>a. REMOVE WING NUT<br>b. DISCONNECT EMISSION CONTROL<br>2. OPEN VALVES WIDE OPEN<br>a. REMOVE RETURN SPRING FROM ACCELERATOR LINKAGE<br>b. PLACE THROTTLE WIDE OPEN |

| STEPS | KEY POINTS |
|---|---|
| | 3. PULL MANUAL CHOKE WIDE OPEN<br>4. UNHOOK LINKAGE TO THE AUTOMATIC CHOKE AND PLACE WIDE OPEN |
| 3. USE REMOTE STARTER | 1. GROUND DISTRIBUTOR END OF COIL SECONDARY WIRE<br>2. INSTALL STARTER SWITCH<br>a. ATTACH ONE LEAD TO THE STORAGE BATTERY POSITIVE CABLE<br>b. ATTACH ONE LEAD TO STARTER SOLENOID<br>c. BE SURE THE CLAMPS ARE ATTACHED TO RESPECTIVE PLACES SECURELY<br>3. LAY STARTER SWITCH ASIDE ON A FLAT SURFACE ACCESSIBLE TO EASY REACH<br>4. WEAR SAFETY GOGGLES |
| 4. USE COMPRESSION GAUGE | 1. INSERT COMPRESSION GAUGE TIGHTLY IN NUMBER 1 CYLINDER<br>a. INSERT GAUGE FITTING IN SPARK PLUG HOLE<br>b. USE ADAPTER IF NECESSARY<br>2. CRANK ENGINE<br>a. TURN ENGINE AT LEAST 4 TIMES<br>b. WATCH GAUGE<br>c. RECORD THE HIGHEST READING<br>3. RELEASE GAUGE NEEDLE<br>4. PROCEED TO OTHER CYLINDER AND CONTINUE COMPRESSION TEST<br>a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS<br>b. RECORD HIGHEST READING FOR EACH OF THE RESPECTIVE CYLINDERS<br>5. COMPRESSION IS TO BE BETWEEN 130-170 PSI. AND A MAXIMUM VARIATION OF 20 PSI. |
| 5. INTERPRETING COMPRESSION READINGS | 1. LOW FIRST STROKE READING WITH LOW FINAL READING<br>a. WARPED VALVES<br>b. BURNED VALVES<br>c. STICKY VALVES |

| STEPS | KEY POINTS |
|---|---|
| | 2. LOW FIRST STROKE WITH MODERATE FINAL READING<br>a. WORN RINGS<br>b. STUCK RINGS<br>c. SCORED RINGS<br>3. TWO ADJACENT CYLINDERS ARE LOW<br>a. BLOWN HEAD GASKET<br>b. WARPED HEAD TO BLOCK |
| 6. COMPARE COMPRESSION | 1. USE COMPRESSION PRESSURE LIMIT FOR TYPICAL VEHICLE TESTING<br>2. ACCORDING TO TEST AND CHART READING DECIDE IF THE ENGINE CAN BE CORRECTED BY A TUNE-UP<br>a. VARIANCES OF MORE THAN PRESCRIBED RANGE INDICATES THAT THE CYLINDERS, RINGS, AND VALVES -- OR ALL THREE - ARE DEFECTIVE<br>b. USE OIL TEST |
| 7. OIL CYLINDERS | 1. RETEST CYLINDERS WITH LOW COMPRESSION<br>a. ADD 1 TABLESPOON OF 30 W. MOTOR OIL<br>b. INSERT COMPRESSION GAUGE<br>c. TURN ENGINE OVER AT LEAST 4 TIMES<br>d. CONSIDERABLE INCREASE IN COMPRESSION MEANS WORN RINGS<br>e. NO SIGNIFICANT INCREASE IN COMPRESSION INDICATES VALVE TROUBLE, BROKEN PISTON, OR BLOWN GASKET<br>2. HIGHER THAN NORMAL COMPRESSION<br>a. ENGINE HAS BEEN MODIFIED TO INCREASE COMPRESSION<br>b. BUILD UP OF CARBON ON THE HEAD OF A PISTON<br><br>CAUTION: IF CARBON BUILD-UP IS CAUSING PINGING THAT CANNOT BE STOPPED BY RETARDING THE TIMING, OR BY SWITCHING TO A HIGHER OC- |

| STEPS | KEY POINTS |
|---|---|
| | TANE GASOLINE, THE CARBON SHOULD BE REMOVED |
| 8. REATTACH THE THROTTLE AND CHECK MECHANISM | 1. CONNECT THROTTLE MECHANISM<br>a. PLACE LINKAGE IN CORRECT POSITION AND RECLASP<br>b. REATTACH SPRING<br>2. CLOSE MANUAL CHOKE<br>3. REATTACH AUTOMATIC CHOKE<br>4. VISUALLY INSPECT FOR THE CORRECT HOOKUP<br>5. TEST THROTTLE MANUALLY |

TASK SHEET VIII-A-9a(TS)

TASK: USE VACUUM GAUGE

JOB: TEST ENGINE VACUUM AND COMPRESSION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VACUUM GAUGE, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. WARM THE ENGINE | 1. ENGINE TO BE WARMED TO OPERATING TEMPERATURE<br>a. SET FOOT OR HAND BRAKE<br>b. PLACE VEHICLE IN PARK OR NEUTRAL<br>c. TURN ON IGNITION<br>d. WATCH TEMPERATURE GAUGE<br>2. RUN ENGINE AT SLIGHTLY HIGHER THAN IDLING SPEED FOR TEST<br>3. TURN ENGINE OFF |
| 2. ATTACH VACUUM GAUGE | 1. ATTACH TO THE INTAKE MANIFOLD<br>2. ATTACH ADAPTER TO AN AVAILABLE PLACE ON THE MANIFOLD (IF AVAILABLE)<br>a. CAN ATTACH TO VACUUM WINDSHIELD WIPERS<br>b. IF WIPERS ARE ELECTRIC, ATTACH TO SOME OTHER VACUUM OPERATED UNIT FITTING |
| 3. MAKE CRANKING TEST | 1. BACK OFF THE IDLE SPEED SCREW TO ALLOW THE THROTTLE VALVE TO FULLY CLOSE<br>2. GROUND THE COIL HIGH TENSION WIRE<br>3. CRANK ENGINE AND AVERAGE READINGS<br>a. RELATIVELY STEADY, HIGH VACUUM INDICATES AN ABSENCE OF VACUUM LEAKS AND GOOD RING AND VALVE ACTION<br>b. LOW BUT FAIRLY STEADY READING CAN MEAN VACUUM LEAKS, WORN VALVE GUIDES, POOR COM- |

| STEPS | KEY POINTS |
|---|---|
|  | PRESSION, VALVE TIMING OFF<br>c. AN ERRATIC READING CAN POINT TO BURNED OR STICKY VALVES, DAMAGED PISTON, BLOWN GASKET<br>4. READJUST IDLE SCREW<br>a. USE APPROPRIATE TOOL<br>b. FOLLOW MANUFACTURER'S SPECIFICATION FOR IDLE SPEED<br>5. REATTACH COIL SECONDARY WIRES TO DISTRIBUTION |
| 4. VACUUM TEST - ENGINE RUNNING | 1. BRING ENGINE TO NORMAL OPERATING TEMPERATURE<br>2. RUN ENGINE AT SLIGHTLY HIGHER THAN NORMAL IDLING SPEED<br>3. NORMAL READING<br>a. NEEDLE WILL BE STEADY AT BETWEEN 17-21 WHEN IDLING<br>b. SUDDENLY OPEN AND CLOSE THE THROTTLE<br>c. NEEDLE WILL DROP TO BELOW 5 THEN BOUNCE UP TO AROUND 25<br>NOTE: SUBTRACT ONE INCH FROM THE SPECIFIED READING FOR EVERY 1,000 FEET OF ELEVATION ABOVE SEA LEVEL<br>4. LEAKING RINGS<br>a. FAIRLY STEADY NEEDLE<br>b. 3-4 POINTS LOWER THAN NORMAL<br>c. SUDDEN OPEN AND CLOSING OF THROTTLE NEEDLE MAY SINK TO ZERO THEN BOUNCE TO ABOUT 22<br>5. SLOW TIMING<br>a. GOOD COMPRESSION<br>b. LOW NEEDLE READING<br>c. A CONSIDERABLE LOW NEEDLE READING MEANS THE VALVE TIMING MAY BE SLOW<br>d. CARBURETOR ADJUSTMENT WILL NOT INCREASE THE VACUUM TO NORMAL - MAKE A CHECK TO SEE IF EITHER OR BOTH, IGNITION OR |

| STEPS | KEY POINTS |
|---|---|
| | VALVE TIMING SHOULD BE ADVANCED |
| | 6. LEAKING INTAKE |
| | a. STEADY NEEDLE |
| | b. 3-9 POINTS LOW |
| | c. THROTTLE VALVE IS NOT CLOSING |
| | d. AIR LEAK EXIST IN CARBURETOR OR INTAKE MANIFOLD OR GASKETS |
| | 7. LEAKING CYLINDER HEAD GASKET |
| | a. FLOATING NEEDLE BETWEEN LOW AND HIGH READING |
| | b. CYLINDER HEAD GASKET BLOWN BETWEEN TWO ADJACENT CYLINDERS |
| | 8. CARBURETOR OUT OF ADJUSTMENT |
| | a. NEEDLE FLOATS SLOWLY |
| | b. RANGE OF 4-5 POINTS |
| | 9. SPARK PLUG GAPS |
| | a. NEEDLE FLOATS SLOWLY OVER A NARROWER RANGE OF ABOUT 2 POINTS |
| | b. SPARK PLUG GAP PROBABLY TOO CLOSE |
| | c. IGNITION POINTS MAY NOT BE OPERATING PROPERLY |
| | 10. RESTRICTED EXHAUST |
| | a. NEEDLE READS NORMAL RANGE UPON STARTING |
| | b. SINKS TO ZERO |
| | c. THEN RISES SLOWLY TO BELOW NORMAL |
| | d. CHECK FOR CLOGGED TAILPIPE |
| | 11. DEFECTIVE VALVE ACTION |
| | a. LEAKING, BURNED, STICKING VALVES, WEAK VALVE SPRINGS, WORN GUIDES |
| | b. ACTION OF NEEDLE AND RANGE OF THE MOTION ARE INDICATION OF A FAULT |
| | 12. ENGINE MECHANICAL CONDITION |
| | a. INDICATION OF LOSS OF COMPRESSION OR IMPROPER VALVE ACTION, TUNE-UP WILL DO NO GOOD, THESE MECHANICAL FAULTS MUST BE |

| STEPS | KEY POINTS |
|---|---|
| | CORRECTED |
| | b. INDICATION OF TIMING ERRORS, INTAKE LEAKS, CARBURETOR OUT OF ADJUSTMENT, OR A RESTRICTED EXHAUST SYSTEM, CORRECT THESE DEFECTS AS THE NEXT STEP |
| 5. REMOVE VACUUM GAUGE | 1. REMOVE VACUUM GAUGE FROM INTAKE MANIFOLD OR ADAPTING POINT |
| | 2. BE SURE TO REPLACE AUTOMOTIVE EQUIPMENT VACUUM HOSES |
| | 3. PRESS VACUUM HOSES COMPLETELY UPON THE FITTING AS DESIGNED |

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

VIII-A-10(S)

| | |
|---|---|
| TASK: | PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM |
| AIM: | 1. THE STUDENTWILL BE ABLE TO PERFORM THE NECESSARY STEPS REQUIRED TO PRESSURE TEST THE ENGINE LIQUID COOLING SYSTEM<br>2. THE STUDENT WILL BE ABLE TO DIAGNOSE ENGINE LIQUID COOLING SYSTEM MALFUNCTIONS<br>3. THE STUDENT WILL BE ABLE TO SERVICE AND REPAIR THE ENGINE LIQUID COOLING SYSTEM |
| TOOLS AND EQUIPMENT: | COOLING SYSTEM PRESSURE TESTER |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | MANUFACTURER'S SPECIFICATIONS, TRANSPARENCIES, I. ED. II 7 T, FIGS. 52-53 |
| REFERENCES: | AUTOMECHANICS, PP. 71-72<br>MOTOR SERVICE'S AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113<br>AUTO SERVICE AND REPAIR, CH. 19<br>AUTOMOTIVE MECHANICS, CH. 12, P. 332 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | MUST HAVE SUCCESSFULLY COMPLETED ALL THE TASKS AND EXHIBITED AN ABILITY TO MAKE JUDGMENTS AND DECISIONS FOR ALL MATERIAL IN VIII-A |
| CHECKING STANDARDS: | 1. SELECT PROPER TOOLS AND EQUIPMENT.<br>2. MAINTAIN CRAFTSMANLIKE WORK.<br>3. APPRECIATION FOR TOOLS, EQUIPMENT, AND AUTOMOBILE.<br>4. FOLLOW STANDARD PROCEDURES AS SET FORTH BY THE INSTRUCTOR. |

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## I. PREPARATION (OF THE LEARNER)

AUTOMOBILE ENGINES ARE COOLED EITHER BY A CLOSED LIQUID COOLING SYSTEM OR AIR COOLED. THE LIQUID COOLING SYSTEM IS THE MOST POPULAR AND REQUIRES MORE MAINTENANCE. BEING ABLE TO SERVICE, REPAIR, MAINTAIN, AND CHECK AN AUTOMOBILE LIQUID COOLING SYSTEM IS A MUST FOR A MECHANIC. THE TOTAL GOOD OPERATION OF AN AUTOMOBILE ENGINE IS DEPENDENT UPON THE COOLING SYSTEM FUNCTIONING PROPERLY. THIS LESSON DEALS WITH THE PRESSURE CHECK OF A LIQUID COOLING SYSTEM, THE DIAGNOSIS OF PROBLEMS FOUND BY THIS TEST, AND POSSIBLE REPAIRS NEEDED TO CORRECT THE PROBLEM.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | FOLLOW PROCEDURE AS SET FORTH IN PRECEDING LESSONS |
| 2. PRIMARY INSPECTION OF COOLING SYSTEM | 1. WHILE ENGINE IS COLD |
| | 2. CAUTION:<br>a. EXPLAIN HAZARD OF PRESSURE IN COOLING SYSTEM<br>b. EXPLAIN PROCEDURE FOR WORKING WITH HOT ENGINE |
| | 3. HOSES<br>a. CRACKS<br>b. LEAKS<br>c. SOFT OR WEAR SPOTS<br>d. HARDENING |
| | 4. REMOVE RADIATOR CAP<br>a. RUST AND CORROSION<br>b. DYE STAINS<br>c. LEAKS<br>d. OIL IN COOLANT<br>e. EXPLAIN SOFT THIN METAL OF RADIATOR IS SUBJECT TO PUNCTURE |
| | 6. SURGE TANK<br>a. OVERALL CONDITION<br>b. OIL IN COOLANT |
| | 7. WATER PUMP<br>a. LEAKING GASKET<br>b. LEAKING SEAL<br>c. WORN BUSHING |
| | 8. BELT<br>a. CORRECT TENSION<br>b. WORN<br>c. FRAYED<br>d. CRACKED<br>e. TOO DEEP OR SHALLOW IN V PULLEY |
| 3. PRESSURE TEST RADIATOR CAP | 1. REMOVE CAP |
| | 2. CLEAN POSSIBLE OIL, RUST, CORROSION |
| | 3. CONNECT CAP TO TESTER (EXPLAIN) |
| | 4. CHECK SPECIFICATIONS FOR CAP |

5. PUMP TESTER AND WATCH GAUGE
6. CHECK THAT VALVE RELEASES AT SPECIFIED PRESSURE
7. DOES CAP VALVE LEAK? DOES CAP VALVE RETAIN TOO MUCH PRESSURE?

4. PRESSURIZE COOLING SYSTEM

SHOW: TRANSPARENCIES
FIGS. 52-53

1. CLEAN RADIATOR FILLER NECK
   a. USE COARSE BRISTLE BRUSH
   b. USE CAUTION, KEEP TRASH OUT OF RADIATOR
   c. USE CLEAN RAG WIPE NECK CLEAN
2. CHECK COOLANT LEVEL. COOLANT MUST BE EVEN WITH FILL LINE. IF LOW ADD COOLANT. IF TOO HIGH REMOVE COOLANT
3. INSTALL PRESSURE TESTER ON RADIATOR NECK (EXPLAIN)
4. CHECK SPECIFICATIONS FOR VEHICLE COOLING SYSTEM PRESSURE RATING
5. PUMP PRESSURE TESTER TO VEHICLE SPECIFIED RATING
6. OBSERVE GAUGE
   a. IF PRESSURE LEAKS DOWN
      (1) RADIATOR
      (2) ENGINE BLOCK
         (a) CRACKS
         (b) FREEZE PLUGS
      (3) WATER PUMP
      (4) HOSES
         (a) UPPER AND LOWER
         (b) BY-PASS
      (5) HEATER
         (a) HOSES
         (b) CORE
   b. IF NO PRESSURE LEAK OCCURS CONTINUE CHECK

5. CHECK FOR INTERNAL LEAKS

1. PRESSURE TESTER GAUGE REMAINS CONNECTED TO SYSTEM
2. START ENGINE
3. IDLE ENGINE UNTIL OPERATING TEMPERATURE IS REACHED
4. APPLY 7 PSI WITH TESTER GAUGE
5. INCREASE ENGINE RPM TO 2000

| | |
|---|---|
| | NOTE: FLUCTUATING GAUGE NEEDLE INDICATES LEAKING HEAD GASKET<br>NOTE: TO CHECK "V" TYPE ENGINE<br>a. DISCONNECT SPARK PLUG WIRES FROM ONE BANK<br>b. ONLY FIRING BANK WILL INDICATE GASKET LEAK |
| 6. TEST COOLANT | 1. START ENGINE<br>2. IDLE ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED<br>3. STOP ENGINE<br>4. CAUTION: COOLANT WILL BE HOT. PRESSURE WILL HAVE BUILT UP IN COOLING SYSTEM<br>5. REMOVE CAP<br>NOTE: BACK CAP OFF TO THE FIRST NOTCH. ALLOW THE PRESSURE TO RELEASE. AFTER PRESSURE HAS BEEN RELEASED REMOVE CAP<br>6. INSERT OPEN END OF TUBE INTO RADIATOR NECK AND INTO COOLANT<br>7. SQUEEZE HYDROMETER BULB AND RELEASE DRAWING COOLANT INTO HYDROMETER<br>a. SQUIRT COOLANT BACK INTO RADIATOR<br>b. REPEAT THIS PROCEDURE UNTIL HYDROMETER TEMPERATURE IS EQUAL TO COOLANT TEMPERATURE<br>8. DRAW COOLANT INTO HYDROMETER ACCORDING TO HYDROMETER MANUFACTURER'S SPECIFICATIONS<br>9. TAKE HYDROMETER READING<br>10. COMPARE THE READING TO COOLANT CHART AND DETERMINE PROTECTIVE TEMPERATURE AND COOLANT TO WATER RATIO |
| 7. PERFORM HOUSEKEEPING CHORES | 1. CLEAN VEHICLE<br>2. REMOVE VEHICLE FROM STALL<br>3. CLEAN TOOLS AND EQUIPMENT |

## II. PRESENTATION (CON'T)

4. RETURN TOOLS AND EQUIPMENT TO STORAGE
5. CLEAN WORK AREA

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## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENT TO GIVE BACK STEPS OF TASK.
2. CHECK STUDENTS FOR COMPREHENSION OF KEY POINTS.
3. CHECK STUDENTS FOR POINTS OF SAFETY.
4. STUDENTS TO PRACTICE ON TASKS.
   USE JOB SHEET, VIII-A-10(J)

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## IV. VERIFICATION AND/OR EVALUATION (CHECK OF STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

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## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP FROM STAGE II AND EMPHASIZE PERTINENT POINTS.
2. PLACE EMPHASIS ON SAFETY.
3. STRESS POINTS CONCERNING CARE OF THE CUSTOMER'S VEHICLE.
4. REEMPHASIZE HIGHLIGHTS OF KEY POINTS.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 2
AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113
AUTO SERVICE AND REPAIR, CH. 19
AUTOMOTIVE MECHANICS, CHS.

THE NEXT LESSON IS: VIII-B-1(S), "SERVICE SPARK PLUGS"

# JOB SHEET

VIII-A-10(J)

JOB: PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

MATERIALS: CLEAN RAGS, COOLANT

TOOLS AND EQUIPMENT: PRESSURE GAUGE, HYDROMETER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THE JOB, READ ALL NECESSARY RELATED INFORMATION:

AUTOMECHANICS, PP. 71-72
AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113
AUTO SERVICE AND REPAIR, CH. 19
AUTOMOTIVE MECHANICS, CH. 12, P. 332

READ DIRECTIONS FOR HYDROMETER USE AS SPECIFIED BY MANUFACTURER. CHECK OUT PRESSURE GAUGE AND HYDROMETER CHECK FOR PROPER PERFORMANCE.

PROCEDURE AND/OR TASKS:

| | | |
|---|---|---|
| PROCEDURE AND/OR TASKS: | VIII-A-10(TS) | PREPARE VEHICLE |
| | VIII-A-10a(TS) | INSPECT COOLING SYSTEM |
| | VIII-A-10b(TS) | PRESSURE TEST RADIATOR CAP |
| | VIII-A-10c(TS) | PRESSURE TEST LIQUID COOLING SYSTEM |
| | VIII-A-10d(TS) | TEST COOLANT |

CHECK POINT: BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK.

CLEAN WORK STATION AS IN PRECEDING TASK

## TASK SHEET

VIII-A-10(TS)

**TASK:** PREPARE VEHICLE

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BATTERY PLIERS, TERMINAL PULLER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. START ENGINE |
| | 2. DRIVE THE VEHICLE IN TO CENTER OF STALL |
| | 3. ALIGN VEHICLE PROPERLY IN STALL |
| | a. USE ASSISTANT |
| | b. HAVE ASSISTANT STAND CLEAR OF VEHICLE |
| | 4. PUT VEHICLE IN PARK |
| | 5. SET FOOT OR HAND BRAKE |
| 2. LET VEHICLE COOL | 1. LET ENGINE COOL UNTIL IT REACHES TOUCHABLE TEMPERATURE |
| | a. HOT ENGINE CAN BURN HANDS |
| | b. HOT RADIATOR COOLANT CAN BURN HANDS |
| | 2. VISUALLY INSPECT COOLING SYSTEM FOR LEAKS |
| 3. PERFORM VEHICLE SAFETY | 1. DISCONNECT NEGATIVE BATTERY CABLE |
| | 2. DISCONNECT POSITIVE BATTERY CABLE |
| | 3. REMOVE KEYS FROM IGNITION |

TASK SHEET VIII-A-10a(TS)

TASK: INSPECT COOLING SYSTEM

JOB: PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BELT TENSION GAUGE, OR STRAIGHT EDGE, SCREWDRIVER, HOSE CLAMP PLIERS, RULER, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK HOSES | 1. NOTE: THIS INSPECTION IS TO BE MADE WHILE THE ENGINE IS COLD<br>2. CRACKS<br>a. RADIATOR, HEATER, AND BY-PASS<br>b. PRESS HOSES AT SEVERAL POINTS BY HAND<br>c. CRACKS WILL OPEN UP<br>3. LEAKS<br>a. HOLE IN HOSE<br>b. AT CLAMPS<br>c. DISCOLORATION ON HOSE, RADIATOR, OR BLOCK WILL INDICATE LEAK<br>4. SOFT OR WEAK SPOTS<br>a. BULGING SPOTS IN HOSE<br>b. PRESS HOSE AT SEVERAL SPOTS BY HAND, GOOD HOSE WILL FEEL PLIABLE AND RETURN TO MATERIAL SHAPE EASILY<br>5. HARDENING<br>a. RESISTANT TO PRESSURE<br>b. WILL PROBABLY CRACK UNDER EXCESS PRESSURE<br>c. IS NOT PLIABLE |
| 2. CHECK RADIATOR CAP | 1. REMOVE RADIATOR CAP<br>a. CHECK FOR PROPER REMOVAL<br>(1) FIRST NOTCH<br>(2) FINAL REMOVAL<br>b. CORROSION<br>c. SEALING GASKET IN GOOD SHAPE<br>d. THE VACUUM VALVE OPERATES FREELY |

| STEPS | KEY POINTS |
|---|---|
| | 2. REPLACE RADIATOR CAP, TIGHTEN DOWN FIRMLY |
| 3. CHECK RADIATOR | 1. REMOVE CAP |
| | 2. RUST AND CORROSION IN TANK |
| | 3. DYE STAINS ON OUTSIDE TANKS AND CORE |
| | 4. LEAKS CORE AND TANKS |
| | 5. OIL IN COOLANT |
| | 6. CHECK SURGE TANK |
| 4. CHECK WATER PUMP | 1. LEAKS<br>a. GASKET<br>b. SEAL |
| | 2. WORN BEARING OR BUSHING<br>a. GRASP BLADE<br>b. WORK BLADE FORWARD AND BACK. EXCESS PLAY INDICATES WORN BEARING, BUSHING, OR LOOSE FAN |
| 5. CHECK BELT | 1. CORRECT TENSION, CHECK SPECIFICATIONS |
| | 2. WORN<br>a. TOO DEEP IN GROOVE<br>b. FRAYED<br>c. CRACKED |

## TASK SHEET

VIII-A-10b(TS)

| | |
|---|---|
| TASK: | PRESSURE TEST RADIATOR CAP |
| JOB: | PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | PRESSURE GAUGE, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN CAP | 1. REMOVE CAP<br>2. WIPE WITH CLEAN RAG<br>a. OIL<br>b. RUST<br>c. CORROSION<br>3. BRUSH WITH MODERATELY FIRM BRISTLE BRUSH |
| 2. CONNECT CAP TO TESTER | 1. INVERT TESTER WITH NECK UP<br>2. PLACE CAP ON NECK BOTTOM SIDE OF CAP DOWN<br>3. TWIST CAP TO RIGHT AND TIGHTEN AS IF ON RADIATOR |
| 3. PRESSURIZE CAP | 1. TURN GAUGE RIGHT SIDE UP<br>2. PUMP BULB OF TESTER TO CAP SPECIFICATIONS WATCH GAUGE<br>3. READ DIAL INDICATOR<br>4. DOES VALVE RELEASE AT SPECIFIED PRESSURE?<br>5. DOES VALVE LEAK?<br>6. DOES VALVE RETAIN TOO MUCH PRESSURE? |

## TASK SHEET

VIII-A-10c(TS)

TASK: PRESSURE TEST LIQUID COOLING SYSTEM

JOB: PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND EQUIPMENT: PRESSURE GAUGE, CLEAN RAGS, BRUSH

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN NECK OF RADIATOR | 1. REMOVE CAP<br>2. USE COARSE BRISTLE BRUSH<br>a. BRUSH OUTSIDE OF NECK<br>b. USE CAUTION TO KEEP TRASH OUT OF RADIATOR<br>3. USE CLEAN RAG<br>a. WIPE INSIDE OF NECK CLEAN OF OIL, RUST, CORROSION<br>b. WIPE NECK SEAT AND OUTSIDE CLEAN |
| 2. CHECK COOLANT LEVEL | 1. CHECK BY SIGHT<br>2. LOOK INTO TOP TANK OR FILLER TANK<br>3. COOLANT MUST BE EVEN WITH FILL LINE<br>a. IF LOW ADD COOLANT TO FILL LINE<br>b. IF OVER FILL LINE REMOVE COOLANT WITH SUCTION BULB |
| 3. INSTALL PRESSURE GAUGE ON NECK | 1. PLACE OVER NECK<br>2. TURN TO RIGHT<br>3. RIGHTEN UNTIL SEATED PROPERLY |
| 4. MAKE PRESSURE TEST | 1. CHECK SPECIFICATIONS FOR VEHICLE COOLING SYSTEM PRESSURE RATING<br>2. OBSERVE GAUGE<br>3. PUMP PRESSURE TESTER TO VEHICLE SPECIFICATIONS<br>4. OBSERVE GAUGE<br>a. IF PRESSURE LEAKS DOWN<br>(1) RADIATOR LEAKS<br>(2) ENGINE BLOCK<br>(a) CRACKED |

| STEPS | KEY POINTS |
|---|---|
| | (b) BAD FREEZE PLUGS<br>(c) BAD GASKET<br>(3) WATER PUMP<br>(a) BAD SEAL<br>(b) BAD GASKET<br>(4) HOSES<br>(a) CRACKED<br>(b) BAD CONNECTIONS<br>(c) HOLES<br>(5) HEATER<br>(a) CORE LEAKS<br>(b) HOLES OR CONNECTIONS LEAK<br>(c) VALVE LEAKS<br>5. IF NO PRESSURE LEAK CONTINUE CHECK |
| 5. CHECK FOR INTERNAL LEAK | 1. PRESSURE TESTER GAUGE REMAINS CONNECTED TO SYSTEM<br>2. START ENGINE<br>3. IDLE ENGINE UNTIL OPERATING TEMPERATURE IS REACHED<br>4. APPLY 7 PSI TO SYSTEM WITH PRESSURE TESTER<br>5. INCREASE ENGINE RPM TO 2000<br>NOTE: FLUCTUATING GAUGE NEEDLE INDICATES LEAKING HEAD GASKET<br>6. "V" TYPE ENGINE CHECK<br>a. DISCONNECT SPARK PLUG WIRES FROM ONE BANK<br>b. ONLY FIRING BANK WILL INDICATE GASKET LEAK |

# TASK SHEET

VIII-A-10d(TS)

**TASK:** TEST COOLANT

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HYDROMETER, COOLANT, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE | 1. START ENGINE<br>2. IDLE ENGINE<br>3. COOLANT IS TO BE AT OPERATING TEMPERATURE<br>4. STOP ENGINE |
| 2. REMOVE RADIATOR CAP | 1. RAISE HOOD<br>2. CAUTION:<br>a. PRESSURE HAS BUILT UP IN SYSTEM, IF CAP IS REMOVED SUDDENLY COOLANT WILL BLOW OUT OF RADIATOR<br>b. COOLANT IS VERY HOT AND SEVERE BURNS CAN BE THE RESULT<br>3. BACK RADIATOR CAP OFF TO FIRST NOTCH<br>4. ALLOW PRESSURE TO RELEASE<br>5. AFTER PRESSURE IS COMPLETELY RELEASED TAKE RADIATOR CAP OFF |
| 3. CHECK COOLANT FAHRENHEIT DEGREES | 1. INSERT OPEN END OF HYDROMETER TUBE INTO RADIATOR NECK AND BELOW COOLANT LEVEL<br>2. SQUEEZE HYDROMETER BULB AND RELEASE<br>a. DRAW COOLANT INTO HYDROMETER BARREL<br>b. SQUEEZE BULB FORCING COOLANT BACK INTO RADIATOR<br>c. CONTINUE TO DRAW COOLANT IN AND OUT UNTIL THE HYDROMETER THERMOMETER IS SAME TEMPERATURE AS COOLANT |

| STEPS | KEY POINTS |
|---|---|
| | 3. DRAW COOLANT INTO HYDROMETER ACCORDING TO MANUFACTURER'S DIRECTIONS<br>a. TAKE HYDROMETER READING<br>b. TAKE TEMPERATURE READING FROM HYDROMETER THERMOMETER<br>4. COMPARE READINGS TO TYPE COOLANT CHART<br>5. DETERMINE PROTECTIVE TEMPERATURE OF COOLANT<br>6. RECORD FINDINGS<br>7. SQUEEZE COOLANT BACK INTO RADIATOR AND REMOVE HYDROMETER FROM RADIATOR<br>8. REPLACE RADIATOR CAP<br>9. CLEAN HYDROMETER ACCORDING TO MANUFACTURER'S DIRECTIONS<br>10. CLOSE HOOD |

## INSTRUCTOR'S PLAN
## INFORMATION LESSON

VIII-B-1(I)

**SUBJECT:** AUTOMOTIVE ENGINE TUNE-UP

**AIM:** THE STUDENT WILL BE ABLE TO APPLY THE INFORMATION PRESENTED IN THIS LESSON TOWARDS MAKING JUDGMENTS AND DECISIONS CONCERNING THE CORRECT OPERATION OF AN AUTOMOBILE ENGINE UNITS AND SYSTEMS NECESSARY FOR ITS PERFORMANCE.

**MATERIAL:** CHALKBOARD ILLUSTRATIONS

**REFERENCES:**
AUTOMOTIVE ENCYCLOPEDIA, PP. 199-204
AUTOMOTIVE MECHANICS, PP. 435-439
AUTO SERVICE AND REPAIR, PP. 23-1 TO 23-12

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENTS MUST HAVE READ THE REFERENCES FOR THIS LESSON.

## I. PREPARATION (OF THE LEARNER- MOTIVATION)

AS ENGINES HAVE BECOME SMALLER, HAVE HIGHER COMPRESSION RATIOS AND MORE HORSEPOWER, TUNE-UPS HAVE BECOME MORE AND MORE IMPORTANT. ENGINE IMPROVED EFFICIENCY HAS COME ABOUT THROUGH AN EFFORT ON THE PART OF MANUFACTURERS TO RAISE QUALITY CONTROL AND HIGHLY IMPROVED MANUFACTURING TECHNIQUES AND METHODS. IN THE PROCESS OF IMPROVEMENT OF THE PRECEDING ITEMS, ENGINE DESIGN HAS BEEN IMPROVED AND BETTER MATERIALS ARE BEING USED. ALL THIS THEN MEANS THAT TOLERANCES ARE CLOSER, PARTS MATING ARE FINER, AND ADJUSTMENTS ARE MORE EXACTING. THEREFORE, SERVICE AND REPAIR METHODS MUST PARALLEL THESE ADJUSTMENTS FOR PERFECT ENGINE OPERATION.

TUNE-UPS ARE OF TWO CATEGORIES - MINOR AND MAJOR. EVEN THOUGH A TUNE-UP IS PERFORMED ON AN ENGINE, IT IS NOT MEANT TO REPAIR MAJOR MECHANICAL PROBLEMS.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. DEFINITION | TUNE-UP REFERS TO CHECKING ALL THE PHASES OF ENGINE OPERATION, MAKING ANY ADJUSTMENTS, REPAIRS, AND PARTS REPLACEMENT FOR ENGINE |

AUXILIARY SYSTEMS AND ACCESSORIES TO CONFORM TO AUTOMOTIVE MANUFACTURER'S SPECIFICATIONS TO APPROXIMATE NEW ENGINE PERFORMANCE

B. TUNE-UP SPECIALIST

1. KNOWS THEORY BEHIND THE OPERATION OF ENGINE AUXILIARY SYSTEMS
2. KNOWS THE TUNE-UP ROUTINE
   - A. DIAGNOSIS
   - B. INSTRUMENT HOOK-UP
   - C. READS INSTRUMENTS
   - D. MAKES JUDGMENTS AND DECISIONS CONCERNING TUNE-UP JOB
   - E. SERVICES
   - F. REPLACES
   - G. MAINTAINS
   - H. REPAIRS
   - I. ADJUSTS
3. KEEPS UP-TO-DATE WITH NEW AUTOMOTIVE SERVICE PROCEDURES
4. KEEPS UP-TO-DATE ON NEW EFFECTIVE METHODS OF CARRYING OUT JOB
5. KEEPS UP-TO-DATE ON NEW EQUIPMENT AND THEIR USES

C. DIVISIONS OF ENGINE OPERATION

1. COMPRESSION
2. IGNITION
3. CARBURETION
4. IF ONE DOES NOT PERFORM PROPERLY THE ENGINE WILL NOT FUNCTION PROPERLY
5. IF THE CONDITION BECOMES VERY INEFFICIENT THE ENGINE WILL NOT RUN AT ALL

D. SATISFACTORY ENGINE PERFORMANCE

1. REQUIRED MAINTENANCE OF ALL NEW ENGINE CONDITIONS
2. MAINTAIN SMOOTH PERFORMANCE
3. REFER TO MANUFACTURER'S SPECIFICATIONS
   - A. ADJUSTMENTS
   - B. OPERATION STANDARDS
4. USE TEST INSTRUMENTS TO DETERMINE CONDITION AND OPERATION OF:
   - A. DISTRIBUTOR, WIRING, AND PLUGS

- B. R.P.M.
- C. GAS PRESSURE
- D. OIL PRESSURE
- E. COOLANT PRESSURE
- F. VACUUM
- G. FUEL EFFICIENCY
- H. COMPRESSION
- I. BELT TENSION

5. AFTER MAINTENANCE PERFORMANCE RECHECK FOR NEW ENGINE OPERATION SPECIFICATIONS
6. PERFORM ANY ADDITIONAL FINAL ADJUSTMENTS FOR SMOOTH ENGINE OPERATION

E. TEST EQUIPMENT

1. NECESSARY FOR:
   - A. TESTS
   - B. ANALYSIS
   - C. ADJUSTMENTS
   - D. SERVICE
   - E. PARTS REPLACEMENT
2. DOES AWAY WITH HAPHAZARD SHADE - TREE METHOD
3. REQUIRES
   - A. KNOWLEDGE OF ENGINE OPERATION
   - B. ELECTRICITY AND ELECTRICAL SYSTEM
   - C. OPERATION AND MAINTENANCE OF EQUIPMENT
   - D. HOOK-UPS
   - E. READING AND INTERPETING READINGS

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III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ESSAY

1. WHY ARE TEST INSTRUMENTS IMPORTANT TO THE TUNE-UP SPECIALIST?

ANSWER: TEST INSTRUMENTS MAKE THE TUNE-UP JOB ACCURATE AND ELIMINATE THE POSSIBILITY OF OMITTING IMPORTANT TESTS, AS WELL AS PERMITTING PRECISE ADJUSTMENTS.

2. WHAT ARE THE DIVISIONS OF ENGINE OPERATION?

ANSWER: THE THREE DIVISIONS OF ENGINE OPERATION ARE COMPRESSION, IGNITION, AND CARBURETION.

3. WHAT IS MEANT BY THE TERM ENGINE TUNE-UP?

ANSWER: IT MEANS TESTING ALL PHASES OF ENGINE OPERATION, MAKING REPAIRS, REPLACEMENT, AND ADJUSTMENTS TO CAUSE AN ENGINE TO PERFORM IN NEW CONDITION.

4. HOW DO ENGINE TUNE-UP AND ENGINE DIAGNOSIS DIFFER?

ANSWER: DIAGNOSIS IS THE ANALYSIS OR TROUBLE SHOOTING OF ENGINE PROBLEMS, WHEREAS TUNE-UP IS THE CORRECTING OF ENGINE PROBLEMS.

5. WHAT IS THE JOB OF THE TUNE-UP SPECIALIST?

ANSWER: THE TUNE-UP SPECIALIST MUST LOCATE AND DETERMINE ENGINE PROBLEMS SUCH AS IMPROPER ADJUSTMENTS AND DEFECTIVE PARTS AND CORRECT THESE CONDITIONS.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

| | | |
|---|---|---|
| 1. | TUNE-UPS ARE OF TWO TYPES ____ AND ____. | MAJOR, MINOR |
| 2. | TUNE-UP REFERS TO CHECKING ALL THE PHASES OF ENGINE ____. | OPERATION |
| 3. | A TUNE-UP IS TO RESTORE AN ENGINE'S OPERATION TO APPROXIMATE ____ ENGINE OPERATION. | NEW |
| 4. | A TUNE-UP SPECIALIST KEEPS UP-TO-DATE ON NEW EFFECTIVE ____ OF CARRYING OUT THE JOB. | METHODS |
| 5. | TEST INSTRUMENTS MUST BE USED WITH ____ AND SPEED. | ACCURACY |
| 6. | THREE DIVISIONS OF THE TUNE-UP PROCEDURE ARE CONSIDERED AS THE ENGINE, THE ELECTRICAL SYSTEM, AND THE ____ SYSTEM. | FUEL |
| 7. | TUNING AN ENGINE DOES NOT MEAN ____ AN ENGINE. | OVERHAULING OR REBUILDING |
| 8. | THE REAL ACCURACY OF CORRECT ADJUSTMENTS IS A ____ CHECK AFTER WORK HAS BEEN COMPLETED. | DOUBLE |
| 9. | CHECKING MANIFOLD ____ IS ONE OF THE MANY CHECKS RUN PRIOR TO A TUNE-UP. | VACUUM |

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

REVIEW EACH MAJOR TOP OF STEP II WITH EMPHASIS PLACED ON MAJOR KEY POINTS.

SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, GLENN, PP. 295-298
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 417-423
AUTOMOTIVE MECHANICS, CROUSE, 237-238, 386-388

THE NEXT LESSON IS: VIII-B-2(I), "SPARK PLUGS"

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

VIII-B-2(I)

**SUBJECT:** SPARK PLUGS

**AIM:** THE STUDENT WILL BE ABLE TO DESCRIBE THE STRUCTURE AND FUNCTION OF SPARK PLUGS IN AN INTERNAL COMBUSTION ENGINE.

**TEACHING AIDS:** FILMS: THE SPARK OF POWER, CHAMPION SPARK PLUG CO.

20,000 VOLTS UNDER THE HOOD, DELCO-REMY DIV. GMC
TRANSPARENCIES I. ED. II. 7T, FIGS, 293, 294, 295, 297, 298, 299, CHALKBOARD
CHART AND MANUAL: AUTOMOTIVE SERVICE MANUAL, CHAMPION SPARK PLUG CO.

MANUAL: SPARK PLUG SERVICE MANUAL, AC SPARK PLUG DIV. GENERAL MOTORS CORP.

**MATERIALS:** CHALK, USED SPARK PLUGS

**REFERENCES:** AUTOMECHANICS, P. 295
AUTOMOTIVE ENCYCLOPEDIA, PP. 405-410
AUTO SERVICE AND REPAIR, CH. 21
AUTOMOTIVE MECHANICS, PP. 242, 368-369

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON.

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

DO YOU KNOW THE IGNITION SYSTEM OF THE CAR YOU RIDE IN PRODUCES OVER 20,000 VOLTS OF ELECTRICITY?

IT NOT ONLY PRODUCES A GREAT AMOUNT OF ELECTRICITY, BUT IT MUST ALSO DELIVER IT TO THE RIGHT PLACE AT EXACTLY THE RIGHT TIME. THE POINT OF DELIVERY,THE SPARK PLUG, IS WHAT WE WILL DISCUSS NEXT.

NOTE: PREVIEW FILM AND TELL STUDENTS WHAT TO NOTICE. SHOW FILM 20,000 VOLTS UNDER THE HOOD AND DISCUSS.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION | 1. USUALLY ONE PLUG PER ENGINE CYLINDER |
| | 2. USUALLY LOCATED AT OR NEAR TOP OF COMBUSTION CHAMBER |
| | 3. IGNITES FUEL-AIR MIXTURE |

- a. AIR AND FUEL DRAWN INTO CYLINDER BY DOWN STROKE OF PISTON
- b. VALVES CLOSE AND PISTON COMES UP COMPRESSING GASES
- c. SPARK PLUG PROVIDES SPARK OF ELECTRICITY CAUSING EXPLOSION
- d. EXPANDING GASES PUSH PISTON DOWN IN POWER STROKE

B. PARTS OF SPARK PLUG

SHOW: TRANSPARENCY FIG. 293

1. ELECTRODES COMPOSED OF HIGHLY CONDUCTIVE MATERIALS
    - a. TERMINAL
    - b. CENTER ELECTRODE
    - c. GAP
    - d. SIDE OR GROUND ELECTRODE
2. INSULATOR MADE OF PORCELAIN OR ALUMINUM OXIDE
    - a. INSULATOR TOP
    - b. RIBS
    - c. CORE NOSE OR TIP
3. STEEL SHELL
    - a. FLATS
    - b. THREADS
    - c. SIDE OR GROUND ELECTRODE
4. INSULATOR SEALS
5. THREAD SEAL

C. FUNCTION OF THE PARTS

1. ELECTRODES
    - a. TERMINAL RECEIVES ELECTRICITY FROM SECONDARY
    - b. THE CENTER ELECTRODE CARRIES CURRENT THROUGH PLUG
    - c. GAP FORCES SPARK TO JUMP
    - d. GROUND ELECTRODE RECEIVES THE SPARK
2. INSULATOR RESTRAINS VOLTAGE AND DISPERSES HEAT
    - a. INSULATOR TOP PROVIDES DISTANCE TO NEAREST GROUND
    - b. THE RIBS REDUCE FLASHOVER TO GROUND
    - c. CORE NOSE PREVENTS SIDE JUMP OF SPARK TO THREADS AND DISPERSES HEAT TO WATER JACKET

3. SHELL PROVIDES STRENGTH AND
   - a. FLATS FOR WRENCH ATTACHMENT
   - b. THREADS FOR SCREWING PLUG IN HEAD
   - c. SIDE OR GROUND ELECTRODE TO RECEIVE THE SPARK
   - d. CRIMPS THE SEALS TO PREVENT COMBUSTION LEAKS

4. SEALS PREVENT COMBUSTION LEAKS AND PROVIDE SUPPORT

5. THREAD SEAL PREVENTS COMBUSTION LEAKS AND TRANSFERS HEAT TO HEAD

D. IMPORTANT VARIATIONS IN DESIGN

1. CENTER ELECTRODE
   - a. BUILT IN RESISTOR REDUCES RADIO STATIC
   - b. AUXILIARY GAP MAKES SPARK HOTTER

SHOW: TRANSPARENCY FIGS. 294, 295, 297, 298, AND 299

2. THREADS
   - a. DIAMETER MATCHED TO THE HEAD HOLE
   - b. REACH EXTENDS INTO CYLINDER

3. INSULATOR TIP

NOTE: DISCUSS PLUG HEAT RANGE HERE

   - a. SHORT HEAVY TIP-COLD PLUG
   - b. LONG THIN TIP-HOT PLUG
   - c. PROJECTED CORE NOSE-SATISFACTORY OVER A WIDER CAR SPEED RANGE

E. FIRING VOLTAGE REQUIREMENTS

1. USUALLY 4 TO 6 THOUSAND VOLTS NECESSARY

2. ARE LESS AVAILABLE AT HIGHER ENGINE SPEED

3. ARE INCREASES WITH
   - a. REVERSE POLARITY
   - b. WIDER SPARK PLUG GAP
   - c. FOULED PLUGS
   - d. HIGHER SPEEDS

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARICIPATING IN DISCUSSION.)

1. WHAT ARE THE THREE MAJOR PARTS OF A SPARK PLUG?

ANSWER: A. ELECTRODES
B. INSULATOR
C. SHELL

2. WHAT IS THE FUNCTION OF THE TERMINAL?

ANSWER: ATTACHES TO DISTRIBUTOR WIRE AND RECEIVES VOLTAGE FROM SECONDARY.

3. WHAT MATERIAL IS THE INSULATOR COMPOSED OF?

ANSWER: PORCELAIN OR ALUMINUM OXIDE.

4. NAME THE ELECTRODES OF A SPARK PLUG.

ANSWER: CENTER ELECTRODE AND SIDE OR GROUND ELECTRODE.

5. WHAT HAPPENS IF THE INSULATOR IS CRACKED?

ANSWER: VOLTAGE GOES TO GROUND THROUGH THE CRACK.

6. HOW DOES THE SPARK TRAVEL IF POLARITY IS REVERSED?

ANSWER: FROM SIDE OR GROUND ELECTRODE TO CENTER ELECTRODE.

7. IS THIS GOOD OR BAD?

ANSWER: BAD. IT REQUIRES MORE VOLTAGE NOT AVAILABLE AT HIGH SPEED AND CAUSES FASTER WEAR ON THE SIDE ELECTRODE.

8. WHAT IS MEANT BY FOULED PLUG?

ANSWER: THE PLUG IS NOT FIRING PROPERLY.

9. DEFINE THREAD REACH.

ANSWER: DISTANCE THE THREADS EXTEND INTO THE CYLINDER.

10. WHAT DETERMINES THE SPARK PLUG HEAT RANGE?

ANSWER: THE LENGTH AND DIAMETER OF THE INSULATOR MEASURED FROM THE SEAL RING TO THE TIP.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED.)

1. HOW MANY VOLTS OF ELECTRICITY CAN A CAR'S IGNITION SYSTEM PRODUCE?

ANSWER: OVER 20,000 VOLTS

2. HOW MANY VOLTS ARE REQUIRED TOFIRE A SPARK PLUG?

ANSWER: USUALLY FROM FOUR TO SIX THOUSAND.

3. WHAT IS THE PRIMARY FUNCTION OF A SPARK PLUG?

ANSWER: TO IGNITE FUEL MIXTURE IN COMPRESSION CHAMBER.

4. IF POLARITY IS NORMAL, WHAT DIRECTION DOES THE SPARK TAKE AT THE ELECTRODES?

ANSWER: CENTER ELECTRODE TO SIDE ELECTRODE OR GROUND.

5. WHY IS THE SPARK PLUG INSULATOR IMPORTANT?

ANSWER: KEEPS THE CURRENT FROM GOING TO GROUND.

6. WHAT IS MEANT BY HEAT RANGE?

ANSWER: OPERATING TEMPERATURE OF THE PLUG.

7. DEFINE THREAD REACH AND THREAD DIAMETER.

ANSWER: REACH DETERMINES DEPTH INTO CYLINDER. DIAMETER DETERMINES THE SIZE HEAD HOLE THE SPARK PLUG FITS.

8. WHAT ARE THE FUNCTIONS OF THE RESISTOR IN A SPARK PLUG?

ANSWER: A. CUTS DOWN ON RADIO AND TELEVISION INTERFERENCE.
B. REDUCES WEAR ON ELECTRODES.

9. WHAT IS THE RELATIONSHIP BETWEEN VOLTAGE AND ENGINE SPEED?

ANSWER: MORE VOLTAGE IS NEEDED BUT LESS IS AVAILABLE AT HIGH SPEED.

10. WHAT IS THE RELATIONSHIP BETWEEN VOLTAGE AND SPARK PLUG GAP?

ANSWER: THE WIDER THE GAP, THE MORE VOLTAGE IS REQUIRED TO MAKE THE SPARK JUMP.

11. NOTE: USE PICTORIAL RECALL TEST ON PARTS OF SPARK PLUG.

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

SHOW FILM THE SPARK OF POWER AND DISCUSS.

1. SPARK PLUGS ARE VERY IMPORTANT IN GASOLINE ENGINES.
2. ALL SPARK PLUGS HAVE THREE BASIC COMPONENTS.
    A. ELECTRODES
    B. INSULATION
    C. SHELL
3. SPARK PLUGS VARY IN THREAD SIZE, THREAD REACH, HEAT RANGE, AND INTERNAL CONSTRUCTION.
4. ENGINE MANUFACTURER'S SUGGESTIONS ARE BASED ON AVERAGE DRIVING CONDITIONS AND USUALLY SHOULD BE FOLLOWED.
5. FIRING VOLTAGE REQUIREMENTS VARY WITH CONDITION OF THE PLUG, ENGINE SPEED, FUEL TYPE, AND POLARITY OF THE IGNITION.

SUGGESTED READING FOR THE STUDENT:
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 417-423

CHART AND MANUAL:
AUTOMOTIVE SERVICE MANUAL, CHAMPION SPARK PLUG CO.

MANUAL:
SPARK PLUG SERVICE MANUAL, AC SPARK PLUG DIV.,
GENERAL MOTORS CORP.

THE NEXT LESSON IS: VIII-B-3(I), "BREAKER POINTS"

## INSTRUCTOR'S PLAN VIII-B-1(S)

## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | SERVICE SPARK PLUGS |
| AIM: | 1. THE STUDENT WILL BE ABLE TO REMOVE, CLEAN, ADJUST, TEST, AND REPLACE PLUGS.<br>2. THE STUDENT WILL BE ABLE TO MAKE JUDGMENTS AND DECISIONS CONCERNING REPLACEMENT OF OLD SPARK PLUGS WITH NEW SPARK PLUGS. |
| TOOLS AND EQUIPMENT: | 3/8" DRIVE SPARK PLUG SOCKET, 3/8" DRIVE UNIVERSAL JOINT, 3/8" DRIVE EXTENSION, 3/8" DRIVE RATCHET HANDLE, SPARK PLUG TERMINAL PLIERS, SPARK PLUG ELECTRODE ADJUSTING TOOL, SPARK PLUG CLEANING AND TESTING MACHINE, WIRE BRUSH, FENDER COVERS, POINT FILE, DROP LIGHT, TORQUE WRENCH, WIRE FEELER GAGE |
| MATERIALS: | CLEAN RAG, SOLVENT |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T, FIGS. 300-305 |
| REFERENCES: | AUTOMECHANICS, CH. 10<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 405-411<br>AUTO SERVICE AND REPAIR, PP. 21-27 TO 21-29<br>AUTOMOTIVE MECHANICS, CH. 15 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE COMPLETED ALL REQUIRED READING ASSIGNMENTS AND STUDIED THE JOB AND TASK SHEETS, VIII-B-1(J) |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS<br>2. TOOL USE<br>3. CRAFTSMANLIKE PERFORMANCE<br>4. APPRECIATION FOR TOOLS, PARTS, MATERIALS, AND CUSTOMER'S VEHICLE<br>5. SAFE WORKING HABITS |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

SPARK PLUGS MUST OPERATE UNDER EXTREMELY HIGH TEMPERATURES, FIRE SEVERAL THOUSAND TIMES PER MINUTE, AND WITHSTAND COMPRESSION FORCES OF SEVERAL HUNDRED POUNDS PER SQUARE INCH.

SPARK PLUG GAPS TEND TO WIDEN, CENTER ELECTRODES BECOME ROUNDED, GROUND ELECTRODES BECOME ROUNDED AND CONCAVE, AND SPARK EROSION TAKES PLACE AFTER SEVERAL THOUSAND MILES OF USE.

SPARK PLUG INSULATION BECOMES COATED WITH CARBON AND LEAD DEPOSITS DEPENDING ON THE CONDITION OF THE ENGINE.

## I. PRESENTATION (CON'T.)

CORRECT SPARK PLUG OPERATION IS IMPORTANT TO THE PERFORMANCE OF AN ENGINE BECAUSE STARTING, IDLING, ACCELERATION, POWER, TOP SPEED, AND GAS MILEAGE ARE AFFECTED.

GAPPING OF SPARK PLUGS MUST BE UNIFORM FOR SMOOTH ENGINE OPERATION AND THE GAP OF NEW SPARK PLUGS MUST BE CHECKED AGAINST MANUFACTURER'S SPECIFICATIONS BEFORE THEY ARE INSTALLED IN THE ENGINE.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PREVIOUS TASKS<br>2. OPEN HOOD<br>3. PLACE FENDER COVERS IN FENDER<br>4. ALLOW ENGINE TO COOL |
| 2. REMOVE SPARK PLUGS | 1. PUT ON GOGGLES<br>2. CHECK BASE OF PLUGS FOR OIL LEAKS<br>3. CAUTIOUSLY USE COMPRESSED AIR AND BLOW THE DUST AND DIRT FROM AROUND BASE OF SPARK PLUG<br>4. REMOVE SPARK PLUG WIRES<br>a. USE TERMINAL PLIERS<br>b. GRIP INSULATOR BOOT AT SPARK PLUG<br>c. TWIST THE BOOT BACK AND FORTH GENTLY<br>d. PULL WIRE FROM SPARK PLUG<br>e. KEEP WIRES IN CORRECT ORDER FOR EASE OF RE-ASSEMBLY<br>5. ASSEMBLE SPARK PLUG SOCKET WITH EXTENSION AND RATCHET HANDLE<br>6. POSITION SPARK PLUG SOCKET OVER PLUG<br>a. MAKE SURE SOCKET HEX IS DOWN OVER SPARK PLUG HEX<br>b. MAKE SURE SPARK PLUG SOCKET INSULATION IS SECURELY DOWN OVER SPARK PLUG INSULATOR<br>7. BACK THE SPARK PLUG OUT COUNTER-CLOCKWISE<br>8. REPEAT KEY POINTS 2-7 FOR ALL PLUGS |

3. INSPECT SPARK PLUGS

1. OIL SOAKED
2. HEAVY CARBON DEPOSITS
3. GAP BRIDGING
4. WORN ELECTRODES
5. CRACKED INSULATOR
6. OVERHEATING

4. CLEAN SPARK PLUGS

1. OIL SOAKED
   a. BRUSH THREADS WITH WIRE BRUSH
   b. WASH PLUG IN CLEAN SOLVENT
   c. DRY PLUG THOROUGHLY
2. PLACE PLUG IN CLEANER
   a. SELECT ADAPTER TO FIT THREAD END OF PLUG
   b. PLACE THREADED END OF PLUG INTO ADAPTER
   c. RAISE SPARK PLUG TESTER HEAD COVER
   d. PLACE THE PLUG AND ADAPTER IN SAND BLAST HOLE OF TESTER

   NOTE: MAKE SURE THE ADAPTER AND PLUG SEALS HOLE SO THAT BLASTING SAND WILL NOT BLOW OUT

3. SAND BLAST PLUG
   a. TURN ON CLEANING MACHINE AIR PRESSURE
   b. USE ONE HAND HOLD PLUG AND ADAPTER IN POSITION
   c. POSITION SWITCH TO SAND BLAST
   d. TURN THE PLUG SLOWLY AROUND SEVERAL TIMES
   e. TURN OFF SAND BLAST
4. REMOVE PLUG FROM CLEANING MACHINE
5. EXAMINE ELECTRODE END OF PLUG FOR CLEANLINESS

   NOTE: CARBON DEPOSITS MUST BE REMOVED FROM ELECTRODES, INSULATOR, AND INSIDE CAVITY OF PLUG

6. AIR BLAST PLUG
   a. REPLACE PLUG IN CLEANING MACHINE
   b. HOLD PLUG DOWN

- c. TURN SWITCH TO AIR CLEAN POSITION
- d. TURN PLUG AROUND SLOWLY SEVERAL TIMES
- e. TURN OFF AIR BLAST SWITCH
- f. REMOVE PLUG FROM ADAPTER
- g. INSPECT PLUG

7. REPEAT KEY POINTS 2 THROUGH 6 FOR REMAINING PLUGS
8. TURN OFF AIR TO TESTER

5. ADJUST SPARK PLUG GAP

1. SQUARE ELECTRODES
   - a. USE POINT FILE
   - b. REMOVE OXIDIZED METAL
   - c. FILE CENTER ELECTRODE FLAT

   NOTE: CURRENT EMITS FROM SHARP CORNERS MUCH MORE READILY THAN FROM BLUNT OR ROUNDED SURFACES. BLUNT OR ROUNDED EDGES CAN REQUIRE AS MUCH AS 30% MORE VOLTAGE TO FIRE A PLUG

   - d. FILE INSIDE SURFACE OF GROUND ELECTRODE FLAT

   NOTE: REMOVE MINIMUM AMOUNT OF METAL FROM ELECTRODES

2. CHECK MANUFACTURER'S SPECIFICATIONS FOR GAP OPENING
3. BEND GROUND ELECTRODE DOWN TOWARD CENTER ELECTRODE, USE GAP ADJUSTING TOOL
4. CHECK GAP WITH WIRE PLUG GAUGE

   NOTE: ADJUST GAP WITH ADJUSTING TOOL UNTIL SPECIFICATIONS ARE MET

5. REPEAT KEY POINTS 1 THROUGH 4 FOR ALL PLUGS

6. TEST SPARK PLUGS

1. SELECT CORRECT SIZE ADAPTER
2. SCREW ADAPTER INTO TESTER
3. SCREW PLUG INTO ADAPTER
4. CONNECT TESTER INSULATED SPARK PLUG LEAD TO SPARK PLUG TERMINAL
5. TURN TESTER GAP ADJUSTMENT RING

TO SPARK PLUG GAP SETTING

6. PRESS TESTER SPARK BUTTON PRODUCING SPARK AT SPARK PLUG GAP
7. OBSERVE SPARK REFLECTION IN TESTER MIRROR
8. TURN TESTER COMPRESSED AIR VALVE ON
9. SLOWLY INCREASE COMPRESSED AIR PRESSURE ON PLUG

NOTE: SPARK AT PLUG GAP SHOULD CONTINUE TO BE STRONG AND BLUE UP TO AT LEAST 150 PSI

10. REPEAT TESTING PROCEDURE FOR ALL PLUGS
11. TURN OFF MACHINE

**7. INSTALL PLUGS IN ENGINE**

NOTE: USE A THREAD LUBRICANT IN THE EVENT PLUGS ARE INSTALLED IN AN ALUMINUM HEAD

1. INSTALL NEW GASKETS ON SPARK PLUG SEATS
2. WIPE CYLINDER HEAD PLUG SEAT WITH CLEAN RAG, TAKE CARE NOT TO WIPE ANY TRASH INTO CYLINDER
3. START ALL PLUGS BY HAND

NOTE: IT MAY BE NECESSARY AT TIMES TO PLACE PLUGS IN SOCKET WITH EXTENSION IN ORDER TO START PLUGS. BE SURE SPARK PLUGS ARE NOT CROSS THREADED IN HEAD

4. TORQUE PLUGS TO MANUFACTURER'S SPECIFICATIONS

NOTE: PROPER TORQUE IS NECESSARY FOR HEAT TRANSFER

**8. INSTALL SPARK PLUG WIRES**

1. ON PLUGS
2. CHECK MANUFACTURER'S SPECIFICATIONS FOR FIRING ORDER
3. PLACE CORRECT WIRE ON THE CORRESPONDING SPARK PLUG
4. SHOVE WIRE TERMINAL UNTIL FIRMLY SEATED

| | | |
|---|---|---|
| | | 5. BE SURE THE TERMINAL LEAD BOOT COVERS PLUG END |
| 9. | NEW PLUGS | 1. IF ANY DOUBT EXISTS CONCERNING SPARK PLUG CONDITION RECOMMEND THAT THEY BE REPLACED WITH NEW PLUGS<br>2. PLUGS SHOULD BE REPLACED IN SETS RATHER THAN ONE OR A FEW AT A TIME<br>3. USE MANUFACTURER'S SPECIFICATIONS AND CROSS-REFERENCE FOR NEW SPARK PLUG SELECTION<br>4. CUSTOMER SATISFACTION FROM QUICK STARTS, ADDED ACCELERATION, AND FUEL ECONOMY CAN OFFSET COST OF NEW PLUGS |
| 10. | CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY STUDENTS UNDER CLOSE SUPERVISION)

1. STUDENTS TO PRACTICE ON JOB UNDER CLOSE SUPERVISION.
2. STUDENTS TO BE FURNISHED WITH JOB SHEET VIII-B-1(J) AND TASK SHEETS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

STUDENTS TO BE PLACED ON THEIR OWN TO PERFORM JOB.

USE PERFORMANCE TEST.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE STEPS OF STAGE II.
   - a. CAUTIONS IN PREPARING VEHICLE FOR JOB.
   - b. SAFETY IN REMOVING JEWELRY WHEN WORKING WITH ELECTRICITY.
   - c. CARE IN REMOVING PLUGS NOT TO BREAK PORCELAIN SPARK PLUG INSULATOR.
   - d. KEEP PLUG WIRES IN CORRECT ORDER FOR REINSTALLING.
   - e. ADHERE TO SPECIFICATIONS WHEN TESTING AND SERVICING PLUGS.
2. ASK STUDENTS TO GIVE BACK KEY POINTS FOR STEPS.

## V. SUMMARY (CON'T.)

3. REDEMONSTRATE ANY OR ALL STEPS IF THE NEED ARISES.

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, CH. 10
AUTOMOTIVE ENCYCLOPEDIA, PP. 447-449
AUTO SERVICE AND REPAIR, PP. 21-7 TO 21-29
AUTOMOTIVE MECHANICS, CH. 15

THE NEXT LESSON IS: VIII-B-2(S), "REMOVE AND REPLACE BREAKER POINTS AND CONDENSOR"

VIII-B-1(J)

# JOB SHEET
# ON
# IGNITION SYSTEM

| | |
|---|---|
| JOB: | SERVICE SPARK PLUGS |
| MATERIAL: | CLEAN RAGS, SOLVENT |
| TOOLS AND EQUIPMENT: | HAND TOOLS, SPARK PLUG TESTER, SPARK PLUG SOCKET, SPARK PLUG TERMINAL PLIERS, WIRE FEELER GAUGE, GAP ADJUSTING TOOL, WIRE BRUSH, TORQUE WRENCH, FENDER COVERS, DROP LIGHT, POINT FILE |
| GENERAL INSTRUCTIONS: | BEFORE BEGINNING THIS JOB READ THE REFERENCES. STUDY THE JOB AND TASK SHEETS. CONFER WITH THE INSTRUCTOR BEFORE OPERATING MACHINE. BE SURE ENGINE IS COOL BEFORE ATTEMPTING TO WORK WITH THE SPARK PLUGS. MAINTAIN CORRECT FIRING ORDER WHEN REMOVING AND REPLACING WIRES. REPORT ANY CRACKED OR BROKEN WIRES TO INSTRUCTOR. DISCUSS SPARK PLUG CONDITION AND TEST RESULTS WITH INSTRUCTOR. |
| PROCEDURE AND/OR TASK: | VIII-B-1(TS) REMOVE SPARK PLUGS<br>VIII-B-1a(TS) CLEAN AND INSPECT SPARK PLUGS<br>VIII-B-1b(TS) ADJUST ELECTRODE CAP AND TEST SPARK PLUG<br>VIII-B-1c(TS) INSTALL SPARK PLUGS |
| CHECK POINTS: | CHECK WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE CONTINUING WITH TASK.<br>1. SELECTION OF TOOLS<br>2. VEHICLE PREPARATION<br>3. TOOL USE<br>4. TEST RESULTS<br>5. SAFETY PRECAUTIONS<br>6. COMPLETING JOB |

## TASK SHEET

**TASK:** REMOVE SPARK PLUGS

**JOB:** SERVICE SPARK PLUGS

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SPARK PLUG TERMINAL PLIERS, AIR HOSE AND AIR, SPARK PLUG SOCKET, HAND TOOLS, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. OPEN HOOD |
| | 2. POSITION DROP LIGHT UNDER HOOD, PLUG INTO POWER AND TURN ON |
| | 3. COVER FENDER WITH FENDER COVERS |
| | 4. ALLOW ENGINE TO COOL |
| 3. REMOVE SPARK PLUG WIRES | 1. WIPE WIRE INSULATOR BOOTS CLEAN WITH CLEAN RAG |
| | 2. GRASP THE INSULATOR BOOT AT SPARK PLUG TERMINAL |
| | 3. TWIST TERMINAL CONNECTION AND BOOT FROM SIDE TO SIDE |
| | 4. PULL TERMINAL LEAD FROM SPARK PLUG WITH PLIERS |
| | 5. REPEAT PROCEDURE FOR ALL PLUGS |
| | 6. INSPECT SPARK PLUG WIRE CONDITIONS |
| 4. CLEAN SPARK PLUG BASE AND ENGINE HEAD | 1. PUT ON GOGGLES |
| | 2. CAUTIOUSLY USE COMPRESSED AIR AND BLOW AROUND BASE OF PLUG AT ENGINE HEAD |
| | 3. BLOW OUT ALL DIRT, OIL, AND DUST |
| | 4. WIPE SPARK PLUG CLEAN WITH CLEAN RAG |
| 5. REMOVE SPARK PLUG | 1. FROM ENGINE |
| | 2. PLACE SPARK PLUG SOCKET FIRMLY DOWN OVER SPARK PLUG |
| | 3. SELECT EXTENSION FOR SOCKET<br>NOTE: IN SOME CASES IT MAY BE NECESSARY TO USE A UNIVERSAL JOINT |

TASK SHEET VIII-B-1a(TS)

TASK: CLEAN AND INSPECT SPARK PLUGS

JOB: SERVICE SPARK PLUGS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, CLEANER-TESTER MACHINE, SOLVENT, WIRE BRUSH, PAN

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN OUTSIDE OF SPARK PLUGS | 1. PUT ON GOGGLES |
| | 2. WASH SPARK PLUGS IN CLEAN SOLVENT |
| | 3. CAUTIOUSLY DRY SPARK PLUGS WITH COMPRESSED AIR |
| | 4. BRUSH THREADS WITH WIRE BRUSH |
| 2. SAND BLAST SPARK PLUG | 1. INSIDE SHELL BOTTOM END |
| | 2. SELECT CORRECT SIZE RUBBER ADAPTER FOR SPARK PLUG THREAD SIZE |
| | 3. RAISE SAND BLASTER COVER LID |
| | 4. POSITION RUBBER ADAPTER OVER SAND BLAST OPENING |
| | 5. INSERT SPARK PLUG IN RUBBER ADAPTER |
| | 6. HOLD SPARK PLUG DOWN FIRMLY |
| | 7. TURN AIR ON TO MACHINE |
| | 8. MOVE MACHINE SWITCH OVER TO "SAND BLAST" POSITION |
| | 9. TURN SPARK PLUG AROUND SLOWLY SEVERAL TIMES |
| | 10. ROCK TOP OF SPARK PLUG BACK AND FORTH SLIGHTLY WHILE TURNING |
| | 11. TURN "SAND BLAST" SWITCH OFF |
| 3. AIR BLAST SPARK PLUG | 1. PUSH MACHINE SWITCH TO "CLEAN" POSITION |
| | 2. TURN PLUG SLOWLY SEVERAL TIMES |
| | 3. ROCK TOP OF PLUG SLIGHTLY WHILE TURNING<br>NOTE: THIS IS TO REMOVE SAND FROM INSIDE SPARK PLUG |
| | 4. TURN "CLEAN" SWITCH OFF |
| | 5. REMOVE SPARK PLUG FROM RUBBER ADAPTER |

| STEPS | KEY POINTS |
|---|---|
| 4. INSPECT SPARK PLUGS | 1. FOR CLEANLINESS<br>2. CRACKED PORCELAIN INSULATOR<br>3. WORN ELECTRODES<br>4. SIGNS OF OVERHEATING<br>5. GAP BRIDGING<br>6. MAKE DECISION<br>a. TO USE SPARK PLUG<br>b. TO REPLACE SPARK PLUG WITH NEW<br>7. REPEAT STEPS 1-4 FOR ALL SPARK PLUGS IN THE SET |

## TASK SHEET VIII-B-1b(TS)

|  |  |
|---|---|
| TASK: | ADJUST ELECTRODE GAP AND TEST SPARK PLUG |
| JOB: | SERVICE SPARK PLUGS |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | WIRE FEELER GAUGE, POINT FILE, GAP ADJUSTING TOOL, SPARK PLUG TESTER MACHINE |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. FILE SPARK PLUG POINTS | 1. USE POINT FILE |
|  | 2. FILE CENTER ELECTRODE FLAT |
|  | 3. FILE OXIDIZED METAL FROM ELECTRODE |
|  | 4. FILE INSIDE OF GROUND ELECTRODE FLAT |
|  | 5. EXERCISE CARE NOT TO FILE AWAY TOO MUCH METAL |
| 2. ADJUST SPARK PLUG POINT GAP | 1. CONSULT MANUFACTURER'S SPECIFICATIONS FOR GAP SIZE |
|  | 2. SELECT WIRE GAUGE SIZE FOR GAP |
|  | 3. SELECT ONE SPARK PLUG |
|  | 4. INSERT WIRE GAUGE OF CORRECT SIZE INTO GAP, CHECK FOR AMOUNT TO BEND GROUND ELECTRODE |
|  | 5. REMOVE GAUGE FROM GAP |
|  | 6. FIT GAP ADJUSTING TOOL SLOT OVER GROUND ELECTRODE |
|  | 7. GENTLY BEND GROUND ELECTRODE TOWARD CENTER ELECTRODE LEAVING GAP APPROXIMATELY CORRECT SETTING |
|  | 8. INSERT WIRE GAUGE INTO GAP TO CHECK FOR CORRECT SETTING |
|  | 9. CONTINUE TO BEND GROUND ELECTRODE UP AND DOWN AND CHECKING WITH WIRE GAUGE UNTIL CORRECT SETTING IS OBTAINED<br>CAUTION: TAKE CARE NOT TO CRACK OR BREAK GROUND ELECTRODE |
|  | 10. REPEAT KEY POINTS 2-9 FOR ALL SPARK PLUGS |

| STEPS | KEY POINTS |
|---|---|
| 3. TEST SPARK PLUG | 1. SELECT CORRECT TESTER ADAPTER FOR SPARK PLUG THREAD SIZE |
| | 2. INSTALL ADAPTER IN TESTER |
| | 3. INSTALL PLUG IN ADAPTER |
| | 4. CONNECT TESTER INSULATED SPARK PLUG LEAD ON TERMINAL OF SPARK PLUG |
| | 5. TURN TESTER ADJUSTMENT SCALE INDICATOR TO PLUG GAP FIGURE |
| | 6. PRESS SPARK CONTROL BUTTON |
| | 7. OBSERVE SPARK AT SPARK PLUG GAP IN TESTER MIRROR |
| | 8. SLOWLY TURN TESTER AIR VALVE ON |
| | 9. GRADUALLY INCREASE AIR PRESSURE WHICH ACTS AS COMPRESSION ON PLUG |
| | 10. CONTINUE TO INCREASE AIR PRESSURE TO 150 PSI OBSERVING SPARK AT PLUG |
| | 11. SPARK AT SPARK PLUG GAP SHOULD CONTINUE TO BE STRONG AND BLUE |
| | 12. RELEASE SPARK CONTROL BUTTON |
| | 13. TURN OFF AIR |
| | 14. REMOVE SPARK PLUG LEAD |
| | 15. REMOVE SPARK PLUG FROM TESTER |
| | 16. REPEAT KEY POINTS 3-15 UNTIL ALL SPARK PLUGS HAVE BEEN TESTED |
| | 17. MAKE DECISION<br>a. TO USE SPARK PLUGS<br>b. TO REPLACE SPARK PLUGS |

## TASK SHEET

VIII-B-1c(TS)

TASK: INSTALL SPARK PLUGS

JOB: SERVICE SPARK PLUGS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SPARK PLUG SOCKET, EXTENSIONS, UNIVERSAL JOINT, RATCHET HANDLE, TORQUE WRENCH, SEAT COVER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN ENGINE SPARK PLUG SEAT | 1. USE CLEAN RAG |
| | 2. WIPE SEAT CLEAN |
| | CAUTION: TAKE CARE NOT TO WIPE ANY FOREIGN MATTER INTO CYLINDER |
| 2. INSTALL SPARK PLUGS | 1. INTO ENGINE SPARK PLUG PORTS |
| | 2. INSTALL NEW METAL GASKETS ON SPARK PLUGS BY SLIDING OVER THE THREADS UP AGAINST SHOULDER |
| | 3. PLACE SPARK PLUG IN SPARK PLUG SOCKET AS FAR AS PLUG WILL GO |
| | 4. PLACE EXTENSION IN SOCKET DRIVE END |
| | 5. PLACE SPARK PLUG THREADS IN ENGINE PLUG PORT |
| | 6. START SPARK PLUG THREADS INTO ENGINE BY HAND MAKING SURE THREADS ARE NOT CROSSED |
| | 7. SCREW SPARK PLUG DOWN AS FAR AS IT WILL GO BY HAND |
| | 8. CHECK MANUFACTURER'S SPECIFICATIONS FOR SPARK PLUG TORQUE |
| | 9. USE RATCHET HANDLE IN DRIVE END OF EXTENSION TO PULL SPARK PLUG DOWN FIRM |
| | 10. USE TORQUE WRENCH IN DRIVE END OF EXTENSION TO APPLY PROPER TORQUE TO SPARK PLUG |
| | 11. REPEAT KEY POINTS 2-10 FOR ALL SPARK PLUGS |
| 3. INSTALL SPARK PLUG WIRES | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR ENGINE FIRING ORDER |

| STEPS | KEY POINTS |
|---|---|
| | 2. SLIDE WIRE TERMINAL OVER SPARK PLUG TERMINAL DOWN AND FIRMLY INTO POSITION |
| | 3. MAKE SURE SPARK PLUG WIRE INSULATOR BOOT IS IN PROPER POSITION OVER SPARK PLUG<br>INSTALL REMAINING WIRES ON SPARK PLUGS IN CORRECT FIRING ORDER |
| 4. CHECK ENGINE PERFORMANCE | 1. PLACE SEAT COVER OVER DRIVER'S SIDE OF SEAT |
| | 2. BE SURE HANDS AND SHOES ARE CLEAN BEFORE ENTERING VEHICLE |
| | 3. ENGAGE PARK BRAKE |
| | 4. PLACE TRANSMISSION IN NEUTRAL |
| | 5. START ENGINE |
| | 6. CHECK ENGINE FOR SMOOTH FIRING |
| | 7. CHECK FOR ELECTRICAL LEAKS AT SPARK PLUG INSULATOR |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-B-3(I)

**SUBJECT:** BREAKER POINTS

**AIM:** THE STUDENT WILL BE ABLE TO IDENTIFY COMPONENTS OF A SET OF BREAKER POINTS AND RELATE THE FUNCTION OF EACH.

**TEACHING AIDS:** TRANSPARENCIES I. ED. 7T, FIGS. 315-322, 332-333

**MATERIALS:** CHALK, USED BREAKER POINTS

**REFERENCES:**
AUTOMECHANICS, GLENN, CH. 10
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 387-404
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21
AUTOMOTIVE MECHANICS, CROUSE, CH. 15 AND 25

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON.

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

WE HAVE LEARNED THAT THE IGNITION SYSTEM OF A CAR CAN PRODUCE OVER 20,000 VOLTS OF ELECTRICITY AND THAT A SPARK PLUG NEEDS SEVERAL THOUSAND VOLTS TO FIRE. GETTING ENOUGH CURRENT IS IMPORTANT, BUT GETTING IT AT EXACTLY THE RIGHT TIME IS EVEN MORE CRITICAL. HOW THE DISTRIBUTOR DELIVERS VOLTAGE IN THE RIGHT AMOUNT AT EXACTLY THE RIGHT TIME AND PLACE IS WHAT WE WILL TAKE UP NEXT.

---

### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION ON BREAKER POINTS | 1. USUALLY ONE SET OF BREAKER POINTS BUT SOMETIMES TWO IN HIGH SPEED ENGINES |
| | 2. ARE LOCATED IN THE DISTRIBUTOR OF MOST ENGINES |
| | 3. OPERATE DUE TO ACTION OF LOBES OF DISTRIBUTOR CAM |
| SHOW: TRANSPARENCIES FIGS. 332, 333 | 4. LOBES ON DISTRIBUTOR CAM EQUAL TO NUMBER OF ENGINE CYLINDERS |

5. CAM TURNS AT ONE-HALF THE ENGINE SPEED
6. FIRE DELIVERED TO EACH CYLINDER ON EVERY SECOND REVOLUTION
7. THE POINTS CLOSE-CURRENT FLOWS THROUGH IGNITION COIL AND BUILDS UP MAGNETIC FIELD
8. POINTS OPEN-CURRENT THROUGH COIL STOPPED AND MAGNETIC FIELD COLLAPSES CREATING A HIGH VOLTAGE CURRENT

B. FUNCTION OF BREAKER POINTS

SHOW: TRANSPARENCIES FIG. 316

1. ACT AS SWITCH TO OPEN AND CLOSE PRIMARY CIRCUIT THROUGH IGNITION
2. DISTRIBUTE HIGH VOLTAGE CURRENT TO ROTOR AT EXACTLY THE RIGHT TIME

C. BREAKER POINT SET AND THEIR PARTS

SHOW: TRANSPARENCIES FIGS. 317-319

1. STATIONARY CONTACT UNIT
    a. MOUNTED ON BREAKER PLATE
    b. HAS ADJUSTMENT SCREW
    c. ADJUSTABLE CONTACT POINT COMPOSED OF TUNGSTEN
    d. POINT GAP - DISTANCE BETWEEN POINTS WHEN FULLY OPEN
2. MOVABLE CONTACT UNIT
    a. ATTACHED BY WIRE TO INSULATED BOLT THROUGH WALL OF DISTRIBUTOR HOUSING
    b. BREAKER POINT SPRING COMPOSED OF FLAT SPRING STEEL
    c. BREAKER ARM
        (1) ATTACHED AT FIBER INSULATED PIVOT POST MOUNTED ON BREAKER PLATE
        (2) FIBER RUBBING BLOCK
        (3) BREAKER ARM CONTACT POINT COMPOSED OF TUNGSTEN

D. FUNCTION OF UNITS AND PARTS

SHOW: TRANSPARENCIES FIGS. 317-322

1. STATIONARY CONTACT UNIT
    a. PROVIDES GROUND TO COMPLETE PRIMARY CIRCUIT WHEN POINTS ARE CLOSED

NOTE: PERIOD WHEN THE POINTS ARE CLOSED IS KNOWN AS DWELL AND ALLOWS COIL TO BUILD UP MAGNETIC FIELD. CAM ANGLE IS NUMBER DEGREES OF ROTATION OF THE DISTRIBUTOR CAM WHEN THE CONTACT POINTS ARE CLOSED

- b. ADJUSTMENT SCREW ALLOWS FOR SETTING CAM ANGLE AND POINT GAP
- c. ADJUSTABLE CONTACT POINT PROVIDES SURFACE FOR FAST CLEAN BREAK IN MAGNETIC FIELD

2. MOVABLE CONTACT UNIT
    - a. ALLOWS PATHWAY FOR HIGH VOLTAGE CURRENT FROM IGNITION COIL THROUGH WALL ATTACHMENT
    - b. BREAKER POINT SPRING CLOSES THE POINTS AND FORCES RUBBING BLOCK AGAINST CAM LOBES
    - c. BREAKER ARM PROVIDES FOR SUPPORT AND ATTACHMENT OF THE BREAKER POINT AND THE RUBBING BLOCK
    - d. RUBBING BLOCK RIDES CONTOURS OF CAM LOBES AND OPENS BREAKER POINTS
    - e. CONTACT POINT PROVIDES SURFACE FOR "MAKING" AND "BREAKING" THE CIRCUIT

E. DUAL POINT SYSTEM

1. REQUIRES A SPECIAL DISTRIBUTOR
2. CUTS DOWN ON OPEN TIME OF CIRCUIT
3. ALLOWS COIL TO BUILD UP STRONGER MAGNETIC FIELD
4. USUALLY FOUND IN HIGH SPEED ENGINES

F. STRUCTURE AND FUNCTION OF DUAL POINTS

1. UTILIZE THE TWO COMPLETE SETS OF BREAKER POINTS
2. MOUNTED ON OPPOSITE SIDES OF THE BREAKER PLATE
3. OVERLAP OPEN AND CLOSE TIME

4. ONE SET CLOSES CIRCUIT TO PERMIT CURRENT FLOW THROUGH PRIMARY
5. OPPOSITE SET OPENS CIRCUIT CAUSING MAGNETIC FIELD COLLAPSE
6. DELIVER MORE VOLTAGE AT HIGH SPEEDS

G. CAUSES OF BREAKER POINT MALFUNCTION

1. CONTACT SPACING OR GAP OUT OF ADJUSTMENT
    a. TOO LITTLE CLEARANCE BURNS POINTS CAUSING POOR SLOW SPEED OPERATION AND HARD STARTING
    b. TOO MUCH CLEARANCE CUTS DOWN ON DWELL PERIOD NOT ALLOWING TIME FOR MAGNETIC SATURATION OF COIL AT HIGH SPEEDS. RESULTS IN WEAK SPARK
2. CONTACT ALIGNMENT OFF CENTER
3. BEARING POST FRICTION AND WEAR
4. TOO LITTLE OR TOO MUCH SPRING TENSION
5. TRANSFER OF METAL BETWEEN POINTS
6. CONTACT "BOUNCE" OR "FLOATING"
7. OXIDIZING OR BURNING
8. RUBBING BLOCK WEAR
9. FOREIGN MATTER BETWEEN POINTS

NOTE: DISPLAY USED BREAKER POINTS SHOWING VARIOUS KINDS OF DAMAGE AND WEAR

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III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

DISCUSS BREAKER POINT PROBLEMS AND ORALLY QUIZ STUDENTS ON CAUSES AND EFFECTS. ILLUSTRATE BREAKER POINTS ON CHALKBOARD AND ASK STUDENTS TO NAME THE PARTS AND THEIR FUNCTIONS.

---

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

TRUE - FALSE TEST

1. THE DISTRIBUTOR CAM LOBES OPERATE THE BREAKER POINTS. T

## IV. VERIFICATION (CON'T.)

2. WHEN THE POINTS ARE CLOSED THE MAGNETIC FIELD BUILDS UP. T
3. A DISTRIBUTOR CAM TURNS ON A 1 : 1 RATIO WITH THE ENGINE. F
4. THE NUMBER OF CAM LOBES IS EQUAL TO THE NUMBER OF CYLINDERS. T
5. A SPARK OCCURS WHEN THE BREAKER POINTS OPEN. T
6. THE STATIONARY CONTACT UNIT IS CONNECTED TO THE COIL. F
7. DWELL ALLOWS FOR BUILDUP OF THE MAGNETIC FIELD. T
8. THE RUBBING BLOCK IS SUPPORTED BY THE BREAKER PLATE. F
9. A DUAL POINT SYSTEM DELIVERS MORE VOLTAGE. T
10. TOO LITTLE SPRING TENSION CAUSES RUBBING BLOCK WEAR. F

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THE SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

BREAKER POINTS ARE VERY IMPORTANT IN THE DISTRIBUTION OF HIGH VOLTAGE TO EACH SPARK PLUG AT EXACTLY THE RIGHT TIME. THEY ARE LIKELY TO WEAR MORE RAPIDLY THAN OTHER PARTS OF THE DISTRIBUTOR, AND, FOR THAT REASON, SHOULD BE CHECKED PERIODICALLY. MANY THINGS CAN CAUSE POINTS TO MALFUNCTION, AND IF SOMETHING GOES WRONG WITH THE IGNITION, THIS IS USUALLY THE FIRST PLACE TO LOOK FOR TROUBLE.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 399-404
AUTO SERVICE AND REPAIR, CH. 21

THE NEXT LESSON IS: VIII-B-4(I), "VOLTAGE CONDENSERS"

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | VOLTAGE CONDENSER |
| AIM: | THE STUDENT WILL BE ABLE TO LOCATE AND IDENTIFY THE VOLTAGE CONDENSER AND RELATE ITS FUNCTION |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T, FIGS. 313-316, 327<br>BLACKBOARD |
| MATERIALS: | CHALK, CUT-AWAY CONDENSERS |
| REFERENCES: | AUTOMECHANICS, CH. 3<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 399-404<br>AUTO SERVICE AND REPAIR, CH. 21<br>AUTOMOTIVE MECHANICS, CH. 15 AND 25 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN THE PREVIOUS LESSON WE LEARNED ABOUT THE DUTIES OF BREAKER POINTS AND HOW TO SERVICE THEM. IF WE INSTALLED A NEW SET AND ADJUSTED THEM PERFECTLY, CHANCES ARE THEY MIGHT STILL BURN UP IN A SHORT WHILE. THE MAGNETIC FIELD IN THE PRIMARY CIRCUIT MUST COLLAPSE QUICKLY AND CLEANLY OR THE POINTS WILL ARC AND BURN AND THERE WILL NOT BE ENOUGH VOLTAGE TO MAKE THE SPARK PLUGS FIRE. THE CONDENSER OR ENERGY RESERVOIR HAS THE MOST IMPORTANT FUNCTION OF STOPPING THE FLOW OF ELECTRICITY, AND THAT IS WHAT WE TAKE UP TODAY.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PRIMARY PURPOSE AND GENERAL INFORMATION | 1. STOPS FLOW OF VOLTAGE THROUGH PRIMARY CIRCUIT CAUSING QUICK COLLAPSE OF MAGNETIC FIELD<br>2. STORES ELECTRIC ENERGY TO PREVENT ARCING ACROSS BREAKER POINTS<br>3. VARIES IN SIZE AND CAPACITY<br>4. CAPACITY MEASURED IN MICRO-FARADS<br>5. AVERAGE SIZE IS .20 MICRO-FARADS |

6. THE COMMON PRACTICE IS CHANGING CONDENSER WHEN POINTS ARE REPLACED

B. CONSTRUCTION

SHOW: TRANSPARENCIES FIGS. 313-314

1. INTERIOR CONSISTS OF TWO LAYERS OR PLATES OF TIN OR LEAD FOIL SEPARATED BY LAYERS OF WAXED PAPER OR MICA INSULATION
2. EACH LAYER OF FOIL EXTENDS BEYOND THE INSULATION AT OPPOSITE ENDS
3. LAYERS OF FOIL AND PAPER ROLLED INTO TIGHT CYLINDER AND INSERTED IN HARD PAPER TUBE
4. TUBE THEN INSERTED IN THE METAL HOUSING
5. SPRING BUTTON ON ONE END FORCES ROLL TIGHTLY TOWARD OPPOSITE END TO CUT DOWN VIBRATION AND PROVIDE CONTACT BETWEEN ONE ROLL OF FOIL WITH HOUSING
6. FOIL ON OPPOSITE END SOLDERED TO METAL DISC WHICH CONNECTS WITH INSULATED LEAD WIRE
7. CONDENSER THEN CAPPED AND THEN SEALED TO KEEP OUT MOISTURE

C. LOCATION

SHOW: TRANSPARENCIES FIGS. 315-316

1. CONDENSER BODY MOUNTED TO DISTRIBUTOR BREAKER PLATE
2. LEAD WIRE ATTACHED TO MOVABLE UNIT OF THE BREAKER POINT SET AND COIL LEAD

D. OPERATION THEORY

1. BREAKER POINTS BEGIN TO OPEN AND CONDENSER ABSORBS SELF - INDUCED VOLTAGE FROM COIL
2. CAUSES SUDDEN STOP OF PRIMARY CURRENT
3. SUDDEN STOP CAUSES COLLAPSE OF MAGNETIC FIELD IN COIL AND LINES OF FORCE CUT THROUGH COIL WINDINGS
4. HIGH VOLTAGE PRODUCED IN SECONDARE CIRCUIT FORCES SPARK TO JUMP GAP OF SPARK PLUG

5. COIL VOLTAGE DECREASES AFTER SPARK OCCURS
6. CONDENSER DISCHARGES ABSORBED ENERGY BACK INTO PRIMARY CIRCUIT
7. DISCHARGED ENERGY SURGES BACK ACROSS BATTERY AND BUILDS UP IN OPPOSITE CONDENSER PLATE
8. CONDENSER DISCHARGES IN OPPOSITE DIRECTION AND CURRENT CHARGES THE ORIGINAL PLATE
9. SOME ENERGY IS LOST IN EACH REVERSAL SO THAT OSCILLATING SOON DIES OUT
10. POINTS CLOSE ALLOWING MAGNETIC FIELD BUILD UP AND CYCLE STARTS OVER
11. GENERAL OPINION IS THE UPPER LIMIT OF THIS CYCLE IS 400 TIMES PER SECOND

E. CONDENSER MALFUNCTIONS

1. CURRENT LEAK CAUSED WHEN FOIL LAYERS ARE IN CONTACT OR HOLE IN INSULATION ALLOWS SPARK TO JUMP BETWEEN LAYERS
2. CONDENSER CAPACITY NOT MATCHED WITH IGNITION SYSTEM CAUSES TRANSFER OF METAL ON BREAKER POINTS
   a. TOO HIGH CAPACITY CAUSES METAL TRANSFER TO NEGATIVE POINT
   b. TOO LITTLE CAPACITY CAUSES METAL TRANSFER TO POSITIVE POINT
   c. METAL BUILDUP AND CRATERS CAUSE BREAKER POINT MALFUNCTION

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATION OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

LIST THE PARTS OF THE CONDENSER ON THE BLACKBOARD AND ASK STUDENTS TO DESCRIBE THEM, TELL THE FUNCTION OF EACH, AND GIVE THE DIRECTION OF CURRENT FLOW FROM THE MOMENT THE POINTS BEGIN TO OPEN UNTIL THEY CLOSE.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

1. WHY CAN YOU CALL A CONDENSER AN ENERGY RESERVOIR?

ANSWER: IT STORES THE OVERFLOW OF ENERGY FROM THE COIL

2. WHAT IS THE PRIMARY PURPOSE IN STORING THE ENERGY?

ANSWER: REDUCES ARCING BETWEEN BREAKER POINTS

3. HOW DO CONDENSERS VARY?

ANSWER: IN SIZE AND CAPACITY

4. WHAT IS THE UNIT OF MEASURE USED IN STATING CONDENSER CAPACITY?

ANSWER: MICRO-FARADS

5. FOILS MADE OF WHAT METALS ARE USED INSIDE CONSENSERS.

ANSWER: LEAD OR TIN

6. WHERE IS THE CONDENSER USUALLY MOUNTED?

ANSWER: ON THE BREAKER PLATE OF THE DISTRIBUTOR

7. TO WHICH UNIT OF THE BREAKER POINTS DOES THE CONDENSER ATTACH?

ANSWER: THE MOVABLE UNIT

8. WHERE DOES THE ENERGY COME FROM THAT THE CONDENSER STORES?

ANSWER: THE COIL

9. NAME THE TERM APPLIED TO THE SURGING OF ENERGY BACK AND FORTH IN THE CONDENSER.

ANSWER: OSCILLATION

10. WHAT HAPPENS TO THE BREAKER POINTS IF CONDENSER CAPACITY DOES NOT MATCH THE IGNITION?

ANSWER: BREAKER POINTS TRANSFER METAL CAUSING BUILDUPS AND CRATERS.

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY BAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS)

THE CONDENSER IS A SMALL BUT VERY IMPORTANT PART OF THE DISTRIBUTOR. WITHOUT ITS FUNCTIONING PROPERLY, THE BREAKER POINTS BURN UP QUICKLY AND THERE IS INSUFFICIENT VOLTAGE TO FIRE THE SPARK

PLUGS. IT ACTS AS AN ENERGY RESERVOIR IN CATCHING THE OVERFLOW OF VOLTAGE FROM THE COIL AND FORCES A QUICK CLEAN BREAKDOWN OF THE MAGNETIC FIELD. MOISTURE AND USE CAUSE CONDENSER WEAR AND EVENTUAL BREAKDOWN, AND FOR THAT REASON IT IS RECOMMENDED THE CONDENSER BE REPLACED PERIODICALLY ALONG WITH THE BREAKER POINTS. CARE SHOULD BE TAKEN IN MATCHING THE CONDENSER CAPACITY TO THE IGNITION SYSTEM.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 399-438
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21

THE NEXT LESSON IS: VIII-B-5(I), "IGNITION TIMING AND TESTING"

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

**SUBJECT:** IGNITION TIMING AND TESTING

**AIM:** THE STUDENT WILL BE ABLE TO IDENTIFY ENGINE TIMING REQUIREMENTS, DESCRIBE HOW THE REQUIREMENTS ARE MET, AND RELATE METHODS AND DEVICES FOR TESTING AN IGNITION SYSTEM.

**TEACHING AIDS:** FILM: 20,000 VOLTS UNDER THE HOOD, DELCO-REMY DIV. GMC, TRANSPARENCIES I. ED. II. 7T, FIGS. 328-335

**MATERIALS:** USED ROTOR WITH CENTRIFUGAL ADVANCE MECHANISM, CUT AWAY OF VACUUM ADVANCE MECHANISM

**REFERENCES:**
AUTOMECHANICS, GLENN, CH. 10
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 399-438
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21
AUTOMOTIVE MECHANICS, CROUSE, CH. 15

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON.

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

BY THIS TIME WE SHOULD ALL SEE THE IMPORTANCE OF THE SPARK PLUGS GETTING ENOUGH VOLTAGE TO FIRE AT EXACTLY THE RIGHT TIME.

WHEN WE START A CAR, TAKE OFF DOWN THE STREET, PASS ANOTHER CAR, OR EVEN STOP FOR A RED LIGHT, THE IGNITION REQUIREMENTS WILL DIFFER EACH TIME. IGNITION SYSTEMS HAVE BUILT IN MECHANISMS TO TAKE CARE OF THESE CHANGES. THOSE DEVICES AND SOME OF THE TOOLS FOR TESTING THEIR EFFICIENCY ARE WHAT WE TAKE UP NEXT.

NOTE: SHOW FILM 20,000 VOLTS UNDER THE HOOD AND DISCUSS

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### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION | 1. IGNITION TIMING ADVANCE MAKES SPARK OCCUR EARLIER |
| | 2. TIMING SHOULD ALLOW COMPLETE BURNING OF FUEL |

3. DETERMINING FACTORS OF IGNITION TIMING REQUIREMENTS
    a. OCTANE RATING OF FUEL
    b. COMPRESSION AND ENGINE SPEED
    c. POWER DEVELOPED AND LOAD CONDITIONS

SHOW: TRANSPARENCIES FIGS. 328, 330, 332, AND 333

4. TIMING SHOULD MATCH ENGINE SPEED AND LOAD CONDITIONS DUE TO TIME
5. TWO TYPES TIMING ADVANCE MECHANISMS USUALLY FOUND IN AN ENGINE

B. TIMING REQUIREMENTS

1. IDLING-ENGINE NOT EMISSION REGULATED
    a. SPARK USUALLY TIMED TO OCCUR JUST BEFORE PISTON REACHES TOP DEAD CENTER OR TDC
    b. SLOW SPEED ALLOWS COMPLETE COMBUSTION
    c. TOTAL PRESSURE APPLIED TO PISTON IN POWER STROKE
2. IDLING-EMISSION REGULATED ENGINE
    a. RETARDED TIMING SPARKS AFTER TOP DEAD CENTER
    b. PERMITS MORE COMPLETE BURNING AND LESS EXHAUST EMISSIONS AT IDLE
    c. ENGINE MUST IDLE FASTER DUE TO RETARDED TIMING
    d. PERFORMANCE AND ECONOMY NOT AS EFFICIENT IN EARLY ENGINES
3. PART THROTTLE WITH MAXIMUM POWER NOT DEMANDED
    a. COMPRESSION PRESSURE LOWER AND RATE OF COMBUSTION SLOWER
    b. TIMING ADVANCED FOR BETTER COMBUSTION
4. FULL THROTTLE AT LOW SPEEDS WITH MAXIMUM POWER DEMAND
    a. MAXIMUM FUEL CHARGE CAUSES HIGHER COMPRESSION
    b. COMBUSTION RATE FASTER THAN SAME ENGINE SPEED AT PART THROTTLE
    c. SPARK ADVANCED TO SMALLER DEGREE

5. HIGH SPEED OPERATION
   - a. IN ACCELERATION, TIMING NOT ADVANCED AS FAR AS IN PART THROTTLE OPERATION
   - b. AT TOP SPEED, THROTTLE FULLY OPEN BUT LESS TIME TO FILL CYLINDER WITH FUEL
   - c. LESS FUEL CAUSES LESS COMPRESSION AND SLOWER RATE OF COMBUSTION
   - d. TIMING ADVANCED TO MAXIMUM AT TOP SPEED

**C. SPARK ADVANCE MECHANISMS**

1. CENTRIFUGAL ADVANCE TYPE
   - a. MAY BE INSIDE ROTOR OR BELOW BREAKER PLATE
   - b. USUAL PARTS ARE: ADVANCE CAM, ADVANCE WEIGHTS, SPRINGS, AND WEIGHT BASE PLATE
   - c. OPERATING PRINCIPLE
     - (1) SPRINGS HOLD IN ADVANCE WEIGHT BASE PLATE
     - (2) INCREASED SPEED FORCES THE WEIGHT TO MOVE OUTWARD
     - (3) MOVEMENT PUSHES WEIGHT ARMS AGAINST ADVANCE CAM
     - (4) ADVANCE CAM ROTATES THE WEIGHT BASE PLATE AND THE DISTRIBUTOR CAM AHEAD ON DISTRIBUTOR SHAFT
     - (5) TIMING ADVANCED CAUSING SPARK EARLIER IN COMPRESSION STROKE

   NOTE: SHOW ROTOR WITH CENTRIFUGAL ADVANCE MECHANISM
2. VACUUM ADVANCE TYPE:
   - a. USUALLY USED IN ADDITION TO CENTRIFUGAL TYPE
   - b. IMPORTANT IN FUEL ECONOMY
   - c. USUAL PARTS: SPRING LOADED AIRTIGHT DIAPHRAGM LINKED TO BREAKER PLATE OR HOUSING, DIAPHRAGM CONNECTED TO CARBURETOR AIR HORN

SHOW: TRANSPARENCIES
FIGS. 331-335

d. OPERATING PRINCIPLE
  (1) NO VACUUM IMPOSED DURING IDLE
  (2) DIAPHRAGM SPRING HOLDS THE BREAKER PLATE AT RETARDED POSITION
  (3) THROTTLE OPENS CAUSING A VACUUM TO MOVE DIAPHRAGM
  (4) DIAPHRAGM COMPRESSES THE SPRING AND ROTATES BREAKER PLATE AGAINST BREAKER ARM ROTATION
  (5) MOVEMENT CAUSES POINTS TO OPEN EARLIER

NOTE: SHOW CUT AWAY OF VACUUM ADVANCE MECHANISM

D. IGNITION TEST MECHANISMS

1. VOLTMETER USED IN TESTING CONTINUOUS CIRCUIT FOR VOLTAGE DROP
2. OHMMETER USED TO TEST HIGH TENSION IGNITION WIRES FOR VOLTAGE LEAKS
3. COIL TEST METER TESTS COIL FOR RESISTANCE AND CONTINUITY OF THE WINDINGS
4. COMMON LEAD PENCIL TESTS POLARITY
5. THE CONTACT POINT TENSION SCALE CHECKS SPRING TENSION IN OUNCES
6. CAPACITOR TESTER CHECKS MICROFARADS OF CAPACITY, SERIES RESISTANCE, AND LEAKAGE IN CONDENSER

SHOW: TRANSPARENCY FIG. 329

7. DWELL METER INDICATES CAM ANGLE DEGREE
8. OSCILLOSCOPE USED TO ANALYZE COMPLETE IGNITION SYSTEM UNDER OPERATING CONDITIONS
9. TIMING LIGHT AND ADVANCE METER TESTS TIMING, ADVANCE MECHANISMS, AND RETARD DEVICES

NOTE: SHOW ALL DEVICES POSSIBLE

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ORAL QUIZ AND DISCUSSION

EXAMPLE:

1. WHAT IS A DWELL METER USED TO TEST?

ANSWER: CAM ANGLE DEGREE OR DWELL

2. UNDER WHAT CONDITION IS ENGINE TIMING FULLY ADVANCED?

ANSWER: WHEN CAR ENGINE AT TOP SPEED

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED.)

OBJECTIVE TRUE - FALSE TEST

1. A COMMON LEAD PENCIL CAN BE USED TO TEST POLARITY. T
2. CAM ANGLE DEGREE IS INDICATED BY AN OHMMETER. F
3. A COIL CAN BE TESTED FOR RESISTANCE TO VOLTAGE. T
4. THE OSCILLOSCOPE CAN BE USED TO CHECK THE ENTIRE IGNITION SYSTEM WHILE THE MOTOR IS RUNNING. T
5. BREAKER POINT TENSION IS TESTED FOR MICRO-FARADS. F
6. A DIAPHRAGM IS PART OF THE VACUUM ADVANCE DEVICE. T
7. FUEL ECONOMY IS GREATER IN AN EARLY EMISSION REGULATED ENGINE. F
8. TYPE AND OCTANE OF FUEL ARE TO BE CONSIDERED IN TIMING REQUIREMENTS. T
9. ENGINES MAY HAVE TWO IGNITION ADVANCE DEVICES. T
10. RETARDED TIMING PERMITS MORE COMPLETE BURNING OF FUEL AT IDLE. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

DIFFERENT SPEEDS AND CONDITIONS CALL FOR DIFFERENT IGNITION TIMING

FOR EFFICIENT OPERATION OF GASOLINE ENGINES. THE MANUFACTURER USUALLY BUILDS TWO DEVICES INTO AN ENGINE TO TAKE CARE OF THE IGNITION DEMANDS. ONE OPERATES ON CENTRIFUGAL FORCE AND THE OTHER ON VACUUM PRODUCED BY THE ENGINE. THERE ARE SEVERAL ELECTRICAL DEVICES FOR CHECKING OUT AN IGNITION SYSTEM, BUT THE MOST IMPORTANT ONE IS PROBABLY THE OSCILLOSCOPE. IT CAN BE USED TO CHECK OUT THE ENTIRE IGNITION SYSTEM, AND, FOR THAT REASON, MOST MODERN REPAIR SHOPS HAVE ONE.

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SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE CH. 15 AND 25

THE NEXT LESSON IS: VIII-B-6(I) "CRANKCASE VENTILATION"

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-B-2(S)

**TASK:** REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

**AIM:**

1. THE STUDENT WILL BE ABLE TO DETERMINE THE NEED FOR REPLACEMENT OF IGNITION BREAKER POINTS AND CONDENSER.
2. THE STUDENT WILL BE ABLE TO REMOVE IGNITION BREAKER POINTS AND CONDENSER; USING THE NECESSARY TOOLS AND EQUIPMENT.
3. THE STUDENT WILL BE ABLE TO INSTALL IGNITION BREAKER POINTS AND CONDENSER, PERFORM THE NECESSARY TESTS, AND MAKE THE CORRECT MECHANICAL AND INSTRUMENT SETTINGS TO CAUSE AN ENGINE TO GIVE MAXIMUM PERFORMANCE; USING THE TOOLS, EQUIPMENT, AND SPECIFICATIONS CALLED FOR IN THE JOB.

**TOOLS AND EQUIPMENT:** HAND TOOLS, FEELER GAUGE, TACHOMETER-DWELL METER, POINT BENDING TOOL, BREAKER ARM SPRING TENSION SCALE, FENDER COVERS, SEAT COVER, DROP LIGHT, COIL-CONDENSER TESTER

**MATERIALS:** CLEAN RAGS, RUBBING BLOCK, LUBRICANT

**TEACHING AIDS:** SPECIFICATIONS, JOB AND TASK SHEETS

**REFERENCES:**
AUTOMECHANICS, PP. 301-311
AUTOMOTIVE ENCYCLOPEDIA, PP. 402-403, 406-412
AUTO SERVICE AND REPAIR, PP. 21-11 TO 21-16
AUTOMOTIVE MECHANICS, PP. 364-365

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE SATISFACTORILY COMPLETED THE PRECEDING LESSONS IN ELECTRICITY, READ THE REFERENCES FOR THIS LESSON, AND STUDIED THE JOB AND TASK SHEETS FOR THIS LESSON.

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. UTILIZATION OF TOOLS AND EQUIPMENT
3. STANDARDS OF PERFORMANCE
4. TASKS COMPLETED AND SPECIFICATIONS ADHERED TO
5. SAFE WORKING HABITS

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE PHYSICAL CONDITION OF IGNITION CONTACT BREAKER POINTS IS VERY

## I. PREPARATION (CON'T.)

IMPORTANT TO PEAK PERFORMANCE OF THE IGNITION SYSTEM. MANY TYPES OF FAILURES OCCUR IN THE IGNITION CONTACT POINTS, MAKING PERIODIC INSPECTIONS A NECESSARY PART OF IGNITION SYSTEM SERVICE.

CONDENSERS BREAK DOWN OR OTHERWISE BECOME DEFECTIVE AND, THEREFORE, REQUIRE REPLACEMENT. TOO, WHEN NEW POINTS ARE INSTALLED A VERY GOOD PRACTICE IS TO INSTALL A NEW CONDENSER.

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. REMOVE DISTRIBUTOR CAP | 1. PLACE SCREWDRIVER UNDER SPRING ARMS<br>2. PULL SCREWDRIVER UP AND AWAY FROM CAP<br>3. SNAP SPRING ARMS OFF DISTRIBUTOR CAP "CAP"<br>4. USE SCREWDRIVER PRESS "L" TYPE LATCH ARM DOWN<br>5. TWIST SCREWDRIVER COUNTERCLOCKWISE<br>6. REMOVE LATCH ARM FROM UNDER DISTRIBUTOR BASE<br>7. LIFT DISTRIBUTOR CAP OFF BASE<br>8. GENTLY MOVE CAP TO ONE SIDE AND WEDGE IT OUT OF THE WAY |
| 4. REMOVE ROTOR CAP | 1. PLACE THUMB OF ONE HAND ON CENTER OF TOP<br>2. STRADDLE DISTRIBUTOR POST WITH INDEX FINGER ON ONE SIDE AND MIDDLE FINGER ON OPPOSITE SIDE<br>3. CURL FINGERS UNDER ROTOR CAP<br>4. GENTLY BUT FIRMLY PULL UP ON ROTOR CAP<br>5. REMOVE ROTOR CAP FROM DISTRIBUTOR POST "OR"<br>6. USE SCREWDRIVER TO UNSCREW TWO HOLD DOWN SCREWS ON EACH SIDE OF ROTOR CAP<br>7. LIFT ROTOR CAP OFF |

| | |
|---|---|
| 5. REMOVE DUST COVER | 1. FROM OVER POINTS<br>2. USE SCREWDRIVER<br>3. BACK OUT SCREWS AT EACH END<br>4. LIFT SCREWS AND DUST COVER OUT OF DISTRIBUTOR BASE |
| 6. REMOVE CONDENSER | 1. USE THIN BLADE ELECTRICAL SCREWDRIVER<br>2. BACK OUT CONDENSER HOLD DOWN CLAMP SCREW, LEAVE SCREW IN CLAMP<br>3. LOOSEN PRIMARY LEAD TERMINAL SCREW<br>a. USE SCREWDRIVER OR WRENCH DEPENDING ON TYPE TERMINAL<br>b. SCREW IS NOT TO BE REMOVED<br>c. LOOSEN SCREW ENOUGH TO LIFT CONDENSER PIG TAIL OFF TERMINAL<br>4. LIFT CONDENSER OUT OF DISTRIBUTOR<br>5. LIFT PRIMARY WIRE OFF TERMINAL |
| 7. REMOVE POINTS | 1. USE SCREWDRIVER<br>2. REMOVE SCREWS FROM EACH END OF BREAKER POINT PLATE<br>NOTE: IF AN ADJUSTING SCREW IS USED IN DISTRIBUTOR BREAKER POINTS SYSTEM IT IS NOT TO BE REMOVED<br>3. LIFT OUT POINTS<br>CAUTION: EXERCISE CAUTION NOT TO LET SCREWS FALL DOWN INTO DISTRIBUTOR |
| 8. TEST CONDENSER | 1. SELECT CONDENSER ACCORDING TO MANUFACTURER'S SPECIFICATIONS<br>2. CONNECT ONE TESTER LEAD TO CONDENSER MOUNTING BRACKET<br>3. CONNECT SECOND TESTER LEAD TO CONDENSER LEAD<br>4. PLUG TESTER INTO POWER OUTLET<br>5. TESTER SET CONTROL SWITCH IN OFF POSITION<br>6. CALIBRATE THE METER NEEDLE TO ZERO |

| | |
|---|---|
| | 7. TURN TESTER SELECTOR SWITCH TO CONDENSER SET POSITION<br>8. ADJUST SET CONTROL SWITCH MOVING THE METER NEEDLE TO THE SET MARK ON THE LEFT SIDE OF THE DIAL |
| A. TEST FOR LEAK | 1. TURN SELECTOR SWITCH TO LEAKAGE POSITION<br>2. NOTE METER READING ON UPPER SCALE<br>3. READING IN GOOD ZONE INDICATES CONDENSER IS WITHIN RECOMMENDED TOLERANCE |
| B. TEST FOR SERIES RESISTANCE | 1. TURN SELECTOR SWITCH TO SERIES RESISTANCE POSITION<br>2. NOTE METER READING ON MIDDLE SCALE<br>3. IF METER NEEDLE IS IN THE RED ZONE, CONDENSER HAS EXCESSIVE RESISTANCE AND SHOULD BE REPLACED |
| C. TEST FOR CAPACITY | 1. TURN SELECTOR SWITCH TO CAPACITY POSITION<br>2. NOTE METER READING ON LOWER SCALE<br>3. METER READING WILL USUALLY BE BETWEEN .2 AND .3 MFD OR READING MUST CONFORM TO MANUFACTURER'S SPECIFICATIONS |
| 9. INSTALL BREAKER POINTS | 1. WIPE DISTRIBUTOR CAM WITH CLEAN RAG<br>2. COAT CAM WITH THIN COAT OF HIGH TEMPERATURE GREASE<br>3. ROTATE CAM UNTIL POINT WIPER WILL REST ON FLAT AREA OF CAM<br>4. PLACE POINTS IN DISTRIBUTOR CONTACT POINTS ON DIRECTION OF ROTATION SIDE OF CAM<br>5. POSITION HOLD DOWN SCREW HOLES WITH SCREW HOLES IN BREAKER PLATE<br>6. INSTALL SCREWS AND TIGHTEN<br>7. INSTALL PRIMARY LEAD ON POINTS |

| | |
|---|---|
| 10. INSTALL CONDENSER | 1. POSITION HOLE IN CONDENSER BRACKET OVER LUG IN BREAKER PLATE<br>2. INSTALL CONDENSER BRACKET SCREW<br>3. ALIGN CONDENSER<br>4. TIGHTEN CONDENSER BRACKET SCREW<br>5. INSTALL CONDENSER PIG TAIL WITH PRIMARY LEAD<br>6. TIGHTEN PRIMARY LEAD NUT OR SCREW |
| 11. ALIGN CONTACT POINTS | 1. CHECK CONTACT POINTS FOR CENTER ALIGNMENT<br>2. BEND STATIONARY CONTACT POINT BRACKET UP OR DOWN TO ALIGN CENTERS<br>3. CHECK CONTACT POINTS FOR ALIGNMENT OF POINT FACES<br>a. USE BENDING TOOL<br>b. BEND STATIONARY CONTACT POINT BRACKET SIDE TO SIDE<br>NOTE: WHEN POINTS ARE PROPERLY ALIGNED THEY SHOULD BE FLUSH TOP TO BOTTOM AND FACES PARALLEL |
| 12. SET BREAKER ARM TENSION | 1. CHECK CONTACT POINT FOR FREE MOVEMENT ON PIVOT<br>2. RUBBING BLOCK ON FLAT SURFACE OF CAM BETWEEN LOBES<br>3. HOOK SCALE ON END OF BREAKER ARM AGAINST CONTACT POINT<br>4. HOLD SCALE AT RIGHT ANGLE TO BREAKER ARM<br>5. PULL OUT ON END OF SCALE MOVING POINTS<br>6. READ SCALE IN OUNCES THE INSTANT POINTS OPEN<br>NOTE: TYPICAL SPECIFICATION FOR CONTACT POINT SPRING TENSION IS 17 TO 20 OUNCES<br>7. ADJUST SLOTTED BREAKER ARM SPRING<br>a. LOOSEN LOCKING NUT<br>b. SLIDE SPRING TOWARD POINT PIN TO DECREASE TENSION |

c. SLIDE SPRING AWAY FROM PIVOT POINT TO INCREASE TENSION
d. TIGHTEN LOCKING NUT

8. ADJUST NON-SLOTTED BREAKER ARM SPRING
   a. DECREASE SPRING TENSION BY GENTLY SQUEEZING SPRING TOGETHER WITH NEEDLE NOSE PLIERS
   b. INCREASE SPRING TENSION
      (1) REMOVE POINTS TO BEND BREAKER ARM
      (2) REPLACE POINTS AND RETEST

NOTE: SOME POINTS ARE FACTORY SET. OTHERS ARE ADJUSTED THROUGH WINDOW IN DISTRIBUTOR CAP OR THOSE WITH FLEXIBLE ARM. ADJUST THESE POINTS AS INDICATED BY MANUFACTURER OR REPLACE WITH ANOTHER SET OF POINTS

13. ADJUST POINT GAP

1. TURN CAM UNTIL RUBBING BLOCK IS CENTERED ON TOP OF ONE LOBE
2. LOOSEN LOCKING SCREWS
3. MOVE BREAKER SUPPORT PLATE BY ADJUSTING SCREW OR SCREWDRIVER IN SLOT
4. INSERT FEELER GAUGE OF RECOMMENDED THICKNESS BETWEEN POINTS
5. ADJUST POINTS UNTIL FEELER GAUGE JUST DRAGS AS IT IS PULLED BETWEEN POINTS

NOTE: WORN POINTS ARE MORE READILY SET WITH DWELL METER

6. TIGHTEN LOCKING SCREWS
7. RECHECK POINT GAP

14. INSTALL ROTOR CAP

1. POSITION ROTOR CAP ON ROTOR SHAFT
2. SHOVE ROTOR CAP DOWN UNTIL IT BOTTOMS ON ROTOR SHAFT, "OR"
3. INSTALL DUST COVER OVER POINTS, INSTALL SCREWS, AND TIGHTEN SCREWS
4. POSITION ROTOR CAP ON CENTRIFUGAL ADVANCE, ROUND LOCATOR LUG AND SQUARE LOCATOR LUGS ON CAP IN PRO-

## II. PRESENTATION (CON'T.)

| | |
|---|---|
| | PER HOLES ON ADVANCE<br>5. INSTALL SCREWS AND TIGHTEN SCREWS |
| 15. INSTALL DISTRIBUTOR CAP | 1. POSITION CAP ON HOUSING<br>2. TWIST CAP BACK AND FORTH UNTIL LUG ON HOUSING FITS NOTCH IN CAP<br>3. SHOVE CAP DOWN ON HOUSING<br>4. LIFT CAP RETAINING CLIPS TO VERTICAL POSITION<br>5. PRESS IN MIDDLE OF CLIPS<br>6. SNAP CLIP ENDS OVER LEDGE ON CAP "ON"<br>7. USE SCREWDRIVER<br>a. PRESS DOWN ON TOP OF SPRING LOADED "L" TYPE CAP LATCH<br>b. TURN LATCH CLOCKWISE SEATING IT IN NOTCH ON BOTTOM SIDE OF DISTRIBUTOR HOUSING |
| 16. TEST DISTRIBUTOR OPERATION | 1. CLEAR TOOLS FROM UNDER HOOD AND OFF ENGINE<br>2. START ENGINE<br>3. RUN ENGINE RPM UP TO 1500 |
| 17. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS ARE TO PRACTICE ON JOB UNDER SUPERVISION.
2. RETEACH IF THE NEED ARISES.
3. USE JOB AND TASK SHEET.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. STUDENTS TO BE PLACED ON THIER OWN TO PERFORM JOB.
2. USE PERFORMANCE TEST.
3. RECORD RESULTS ON PROGRESS CHART.

## V. SUMMARY (TELL THE THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY.

2. POINT OUT THAT RAGS MAY BE PLACED IN OPENINGS INSIDE DISTRIBUTOR BEFORE POINTS ARE REMOVED AND DURING POINT REPLACEMENT TO KEEP BOLTS, NUTS, SCREWS, AND FOREIGN MATTER FROM FALLING DOWN INSIDE DISTRIBUTOR.

3. EMPHASIZE ACCURACY:
   a. INSTALLING POINTS
   b. ALIGNING CONTACT POINTS
   c. SETTING CONTACT ARM SPRING TENSION
   d. SETTING POINT GAP AND ANGLE OF DWELL

4. POINT OUT DIFFERENT TYPES OF DISTRIBUTORS.

5. EMPHASIZE PERTINENT KEY POINTS OF EACH STEP OF THE JOB.

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 308, 311-313
AUTOMOTIVE ENCYCLOPEDIA, P. 413
AUTOMOTIVE MECHANICS, PP. 365-368

THE NEXT LESSON IS: VIII-B-3(S), "CHECK AND ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL AND TIMING"

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## JOB SHEET VIII-B-2(J)

**JOB:** REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

**MATERIAL:** POINTS, CONDENSER, CLEAN RAGS, HIGH TEMPERATURE LUBRICANT

**TOOLS AND EQUIPMENT** HAND TOOLS, FEELER GAUGE, POINT BENDING TOOL, SEAT COVER, TACHOMETER, FENDER COVER, DROP LIGHT, BREAKER ARM SPRING, TENSION SCALE, COIL-CONDENSER TESTER

**GENERAL INSTRUCTIONS:** BEFORE STARTING THE JOB READ REFERENCES. STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE OPERATING EQUIPMENT OR STARTING ENGINE.

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-B-2(TS) | REMOVE POINTS AND CONDENSER |
| VIII-B-2a(TS) | TEST CONDENSER |
| VIII-B-2b(TS) | INSTALL IGNITION BREAKER POINTS AND CONDENSER |
| VIII-B-2c(TS) | MAKE IGNITION BREAKER POINT ADJUSTMENTS |
| VIII-B-2d(TS) | INSTALL ROTOR CAP AND DISTRIBUTOR CAP |

## TASK SHEET VIII-B-2(TS)

**TASK:** REMOVE POINTS AND CONDENSER

**JOB:** REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. REMOVE DISTRIBUTOR CAP | 1. PLACE SCREWDRIVER UNDER CAP RETAINING CLIP |
| | 2. PRY CLIP OFF LIP ON CAP |
| | 3. REPEAT PROCEDURE FOR SECOND CLIP "OR" |
| | 4. USE SCREWDRIVER PRESS "L" TYPE LATCH ARM DOWN |
| | 5. TWIST LATCH COUNTERCLOCKWISE REMOVING LATCH ARM FROM UNDER HOUSING |
| | 6. REPEAT PROCEDURE FOR SECOND LATCH |
| | 7. LIFT DISTRIBUTOR CAP FROM BASE |
| | 8. GENTLY MOVE CAP TO ONE SIDE AND WEDGE IT OUT OF THE WAY |
| 4. REMOVE ROTOR CAP | 1. PLACE THUMB OF ONE HAND ON CENTER OF TOP |
| | 2. STRADDLE ROTOR POST WITH INDEX AND MIDDLE FINGERS OF SAME HAND |
| | 3. CURL FINGERSUNDER ROTOR CAP ENDS |
| | 4. GENTLY BUT FIRMLYWORK ROTOR CAP OFF CAM POST "OR" |
| | 5. USE SCREWDRIVER |
| | 6. REMOVE SCREWS FROM EACH SIDE OF CAP |
| | 7. LIFT ROTOR CAP OFF |
| 5. REMOVE DUST COVER | 1. FROM POINTS |

| STEPS | KEY POINTS |
|---|---|
| | 2. PLACE RAGS IN SLOTS AND HOLES INSIDE BASE OF DISTRIBUTOR, KEEP NUTS, BOLTS, AND DIRT FROM FALLING DOWN INTO DISTRIBUTOR<br>3. USE SCREWDRIVER<br>4. BACK OUT SCREW AT EACH END<br>5. LIFT SCREWS AND DUST COVER OUT OF DISTRIBUTOR BASE |
| 6. REMOVE CONDENSER | 1. USE THIN BLADE ELECTRICAL SCREWDRIVER<br>2. BACK OUT CONDENSER HOLD DOWN SCREW, LEAVE SCREW IN CLAMP<br>3. LOOSEN PRIMARY LEAD TERMINAL SCREW<br>a. USE SCREWDRIVER OR WRENCH DEPENDING ON TYPE TERMINAL<br>b. BOLT OR SCREW IS NOT TO BE REMOVED<br>4. LIFT PIG TAIL TERMINAL LEAD OFF PRIMARY TERMINAL<br>5. REMOVE CONDENSER FROM DISTRIBUTOR |
| 7. REMOVE BREAKER POINTS | 1. USE SCREWDRIVER<br>2. REMOVE SCREWS FROM EACH END OF BREAKER POINT PLATE<br>3. LIFT OUT POINTS |

## TASK SHEET

VIII-B-2a(TS)

**TASK:** TEST CONDENSER

**JOB:** REMOVE AND REPLACE INGITION BREAKER POINTS AND CONDENSER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** COIL-CONDENSER TESTER, CONDENSER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE CONDENSER FOR TEST | 1. SELECT CONDENSER ACCORDING TO MANUFACTURER'S SPECIFICATIONS |
| | 2. CONNECT POSITIVE LEAD OF TESTER TO CONDENSER LEAD TERMINAL |
| | 3. CONNECT NEGATIVE LEAD OF TESTER TO CONDENSER MOUNTING BRACKET |
| | 4. TURN TESTER SET CONTROL SWITCH TO OFF POSITION |
| | 5. PLUG TESTER INTO POWER SOURCE |
| | 6. CALIBRATE METER NEEDLE TO ZERO |
| | 7. TURN TESTER SELECTOR SWITCH TO CONDENSER SET POSITION |
| | 8. ADJUST SET CONTROL SWITCH MOVING METER NEEDLE TO SET MARK ON LEFT SIDE OF DIAL |
| 2. TEST CONDENSER FOR LEAKS | 1. TURN SELECTOR SWITCH TO LEAKAGE POSITION |
| | 2. NOTE METER READING ON UPPER SCALE |
| | 3. READING IN GOOD ZONE INDICATES CONDENSER IS IN RECOMMENDED TOLERANCE |
| | 4. IF NEEDLE IS NOT IN GOOD ZONE SELECT ANOTHER CONDENSER |
| 3. TEST CONDENSER FOR SERIES RESISTANCE | 1. TURN SELECTOR SWITCH TO SERIES RESISTANCE POSITION |
| | 2. NOTE METER READING ON MIDDLE SCALE |
| | 3. IF METER NEEDLE IS IN RED ZONE, CONDENSER HAS EXCESSIVE RESIST- |

| STEPS | KEY POINTS |
|---|---|
| | ANCE, SELECT ANOTHER RESISTOR |
| 4. TEST CONDENSER FOR CAPACITY | 1. TURN SELECTOR SWITCH TO CAPACITY POSITION |
| | 2. NOTE METER READING ON LOWER SCALE |
| | 3. METER READING WILL USUALLY BE BETWEEN .2 AND .3 MFD OR METER READING MUST CONFORM TO MANUFACTURER'S SPECIFICATIONS |
| | 4. TURN TESTER OFF |
| | 5. REMOVE POWER LEAD FROM POWER SOURCE |
| | 6. REMOVE CONDENSER FROM TEST LEADS |

## TASK SHEET

VIII-B-2b(TS)

TASK: INSTALL IGNITION BREAKER POINTS AND CONDENSER

JOB: REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, POINTS SET, CONDENSER, HIGH TEMPERATURE GREASE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. INSTALL POINTS | 1. WIPE INSIDE OF DISTRIBUTOR CLEAN<br>2. WIPE DISTRIBUTOR CAM CLEAN<br>3. COAT DISTRIBUTOR CAM WITH THIN COAT OF HIGH TEMPERATURE GREASE<br>4. BUMP ENGINE OVER WITH STARTER UNTIL FLAT AREA OF DISTRIBUTOR CAM IS OPPOSITE BREAKER POINT WIPER<br>5. PLACE BREAKER POINTS IN DISTRIBUTOR, CONTACT POINTS ON SIDE OF CAM IN DIRECTION OF ROTATION OF CAM<br>6. ALIGN HOLES IN BREAKER POINT BASE WITH HOLES IN BREAKER PLATE<br>7. INSTALL SCREWS IN EACH END OF BREAKER POINT BASE<br>8. TIGHTEN SCREWS<br>9. LOOSEN PRIMARY IGNITION TERMINAL NUT ON POINTS<br>10. INSTALL IGNITION PRIMARY LEAD ON BREAKER POINTS PRIMARY LEAD TERMINAL |
| 2. INSTALL CONDENSER | 1. PLACE CONDENSER BRACKET ON FLAT SURFACE, FLAT SIDE DOWN<br>2. ROTATE CONDENSER IN BRACKET UNTIL OPEN SIDE OF PIG TAIL TERMINAL IS DOWN<br>3. SLIDE CONDENSER IN POSITION END TO END IN BRACKET SO IT WILL CLEAR DISTRIBUTOR HOUSING WHEN IT IS INSTALLED<br>4. PLACE CONDENSER IN DISTRIBUTOR |

| STEPS | KEY POINTS |
|---|---|
| | 5. POSITION HOLES IN CONDENSER BRACKET OVER LUGS ON BREAKER PLATE |
| | 6. INSTALL BRACKET SCREW AND TIGHTEN |
| | 7. POSITION CONDENSER PIG TAIL TERMINAL ON PRIMARY TERMINAL WITH PRIMARY LEAD FROM COIL |
| | 8. TIGHTEN PRIMARY LEAD TERMINAL |

## TASK SHEET

VIII-B-2c(TS)

TASK: MAKE IGNITION BREAKER POINT ADJUSTMENTS

JOB: REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: POINT BENDING TOOL, FEELER GAUGE, HAND TOOLS, BREAKER ARM SPRING TENSION SCALE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. ALIGN CONTACT POINT CENTERS | 1. CENTERS MAY BE OFF IN ANY DIRECTION |
| | 2. USE POINT BENDING TOOL |
| | 3. BEND STATIONARY POINT BRACKET TO ALIGN CENTERS |
| | 4. BEND BRACKET VERY SMALL AMOUNT AND RECHECK CENTER ALIGNMENT |
| | 5. MAKE CENTER ALIGNMENT AS NEAR PERFECT AS POSSIBLE |
| 2. ALIGN CONTACT POINT FACES | 1. FLAT POINTS - ENTIRE SURFACE OF BOTH CONTACT POINTS ARE TO COME TOGETHER AND TOUCH AT ONCE |
| | 2. BOTH CONTACT POINTS CONVEX-POINT OUTSIDE DIAMETERS ARE TO BE MATCHED AND CONTACT IS TO BE IN THE CENTER OF THE POINTS |
| | 3. ONE CONTACT POINT CONVEX AND THE OTHER FLAT-POINT OUTSIDE DIAMETERS ARE TO BE MATCHED AND CONTACT IS TO BE IN THE CENTER OF THE POINTS |
| | 4. USE POINT BENDING TOOL |
| | 5. BEND STATIONARY POINT BRACKET TO ALIGN CONTACT POINT FACES |
| | 6. BEND BRACKET VERY SLIGHTLY AND RECHECK POINT FACE ALIGNMENT |
| | 7. MAKE POINT FACE ALIGNMENT AS NEAR PERFECT AS POSSIBLE |
| 3. BREAKER ARM TENSION | 1. SOME POINTS HAVE SLOTTED SPRINGS FOR TENSION ADJUSTMENT |
| | 2. SOME SPRINGS MUST BE BENT WITH |

| STEPS | KEY POINTS |
|---|---|
| | NEEDLE NOSE PLIERS TO ADJUST TENSION<br>3. SOME POINTS SUCH AS THOSE ADJUSTED THROUGH A WINDOW IN THE DISTRIBUTOR CAP OR PIVOTLESS TYPE HAVE THE SPRING TENSION ADJUSTED AT THE FACTORY. THESE POINTS ARE TO BE CHECKED, ADJUSTED AS RECOMMENDED BY THE MANUFACTURER, OR REPLACED IF THEY DO NOT COME UP TO STANDARDS |
| 4. SET BREAKER ARM TENSION | 1. CHECK CONTACT POINT FOR FREE MOVEMENT ON PIVOT<br>2. RUBBING BLOCK IS TO BE ON FLAT SURFACE OF CAM BETWEEN LOBES SO THAT POINTS WILL BE CLOSED<br>3. USE BREAKER ARM SPRING TENSION SCALE<br>4. HOOK SCALE ARM ON END OF BREAKER ARM AS CLOSE TO CONTACT POINT AS POSSIBLE<br>5. SCALE IS TO BE HOOKED TO BREAKER ARM SO THAT WHEN STRAIN IS APPLIED POINTS WILL BE PULLED APART<br>6. HOLD BODY OF SCALE AT RIGHT ANGLE TO BREAKER ARM<br>7. PULL ON SCALE BODY END AWAY FROM POINTS MOVING BREAKER ARM<br>8. TAKE SCALE READING AT THE INSTANT CONTACT POINTS OPEN<br>NOTE: TYPICAL SPECIFICATIONS FOR CONTACT POINT SPRING TENSION IS 17 TO 20 OUNCES<br>9. ADJUST SLOTTED BREAKER ARM SPRING<br>a. LOOSEN LOCKING NUT<br>b. MOVE SPRING VERY SLIGHT AMOUNT AT A TIME<br>c. DECREASE SPRING TENSION BY SLIDING SPRING TOWARD PIVOT POINT<br>d. INCREASE SPRING TENSION BY |

| STEPS | KEY POINTS |
|---|---|
| | SLIDING SPRING AWAY FROM PIVOT POINT<br>10. ADJUST FIXED BREAKER ARM SPRING<br>a. DECREASE SPRING TENSION BY GENTLY SQUEEZING SPRING TOGETHER<br>b. USE NEEDLE NOSE PLIERS, PLIERS STRADDLING PIVOT POINT AND SPRING<br>c. INCREASE SPRING TENSION<br>(1) REMOVE BREAKER POINTS FROM DISTRIBUTOR<br>(2) BEND BREAKER ARM<br>(3) REPLACE BREAKER POINTS AND RETEST |
| 5. ADJUST BREAKER POINT GAP | 1. BUMP ENGINE OVER WITH STARTER<br>2. CENTER WIPER ON THE VERY TOP OF A CAM LOBE<br>3. LOOSEN BREAKER POINT SUPPORT PLATE LOCKING SCREWS<br>4. MOVE BREAKER SUPPORT PLATE<br>a. ADJUSTING CAM AND SCREWDRIVER<br>b. SCREWDRIVER IN BREAKER PLATE SLOT AND BREAKER SUPPORT PLATE<br>c. ALLEN WRENCH IN ADJUSTING SCREW<br>5. CHECK MANUFACTURER'S SPECIFICATIONS FOR GAP WIDTH<br>6. SELECT FEELER GAUGE OF CORRECT THICKNESS<br>7. INSERT FEELER GAUGE IN BREAKER POINT OPENING<br>8. MOVE POINTS IN OR OUT AS NEEDED WITH ADJUSTMENT<br>9. ADJUST POINTS UNTIL FEELER GAUGE JUST DRAGS AS IT IS PULLED BETWEEN POINTS<br>10. TIGHTEN BREAKER POINT SUPPORT PLATE LOCKING SCREWS<br>11. RECHECK POINT GAP WITH FEELER<br>12. REMOVE RAGS FROM DISTRIBUTOR |

## TASK SHEET VIII-B-2d(TS)

**TASK:** INSTALL ROTOR AND DISTRIBUTOR CAP

**JOB:** REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SCREWDRIVER, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. INSTALL ROTOR CAP | 1. WIPE ROTOR CLEAN WITH RAG |
| | 2. POSITION ROTOR CAP ON DISTRIBUTOR ROTOR SHAFT |
| | 3. TURN ROTOR CAP UNTIL SLOT AND GROOVE ALIGN OR MACHINE AREA OF POST ALIGNS WITH FLAT AREA INSIDE ROTOR CAP |
| | 4. PRESS ROTOR CAP DOWN UNTIL IT FIRMLY BOTTOMS ON DISTRIBUTOR SHAFT, "OR" |
| | 5. POSITION ROTOR CAP ON CENTRIFUGAL ADVANCE |
| | 6. TURN ROTOR CAP UNTIL ROUND AND SQUARE LUGS FALL INTO LIKE DEPRESSIONS IN CENTRIFUGAL ADVANCE |
| | 7. INSTALL SCREWS IN EACH SIDE OF ROTOR CAP |
| | 8. TIGHTEN SCREWS SECURELY |
| 2. INSTALL DISTRIBUTOR CAP | 1. WIPE INSIDE OF DISTRIBUTOR CAP CLEAN WITH CLEAN RAG |
| | 2. POSITION CAP ON DISTRIBUTOR HOUSING |
| | 3. GENTLY TWIST CAP BACK AND FORTH UNTIL CAP SLOT DROPS OVER LUG ON HOUSING |
| | 4. MAKE SURE CAP IS FIRMLY SEATED ON HOUSING LEDGE ALL AROUND |
| | 5. LIFT CAP RETAINER CLIPS TO VERTICAL POSITION |
| | 6. SPAN DISTRIBUTOR WITH ONE HAND<br>a. PLACE THUMB ON MIDDLE OF ONE CLIP |

| STEPS | KEY POINTS |
|---|---|
| | b. PLACE FINGERS ON MIDDLE OF SECOND CLIP |
| | 7. FIRMLY HOLD CAP DOWN WITH SECOND HAND |
| | 8. SQUEEZE CLIP WITH HAND ON CLIPS |
| | 9. SNAP CLIP ENDS OVER LEDGE ON CAP "OR" |
| | 10. USE SCREWDRIVER |
| | 11. USE ONE HAND HOLD CAP DOWN FIRMLY |
| | 12. USE SCREWDRIVER |
| | a. PRESS DOWN ON TOP OF SLOTTED, SPRING LOADED "L" TYPE CAP LATCH |
| | b. TURN CAP LATCH CLOCKWISE |
| | c. SEAT "L" OF CAP LATCH IN NOTCH ON BOTTOM SIDE OF DISTRIBUTOR HOUSING |
| | d. REPEAT PROCEDURE FOR SECOND LATCH |
| 3. TEST DISTRIBUTOR OPERATION | 1. CLEAR TOOLS FROM UNDER HOOD, OFF ENGINE AND FENDERS |
| | 2. PLACE TRANSMISSION IN NEUTRAL |
| | 3. SET PARK BRAKE |
| | 4. START ENGINE |
| | 5. LISTEN FOR UNUSUAL NOISES |
| | 6. ALLOW ENGINE TO IDLE |
| | 7. CHECK FOR MISSING OR ROUGH ENGINE OPERATING |
| | 8. INCREASE ENGINE RPM TO MODERATE SPEED OR APPROXIMATELY 1500 RPM |
| | 9. LISTEN TO ENGINE OPERATION |
| | 10. STOP ENGINE |
| 4. CLEAN WORK STATION | AS IN PRECEDING JOB |

VIII-B-3(S)

# INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** CHECK AND ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL AND TIMING

**AIM:**

1. THE STUDENT WILL BE ABLE TO SET UP AND CONNECT TEST EQUIPMENT TO AN AUTOMOTIVE IGNITION SYSTEM IN PREPARATION FOR TESTING BREAKER POINT OPERATION AND ENGINE TIMING.
2. THE STUDENT WILL BE ABLE TO PERFORM TESTS REQUIRED TO DETERMINE IGNITION TIMING BREAKER POINT ANGLE OF DWELL AND ENGINE TIMING; USING MANUFACTURER'S SPECIFICATIONS, TEST EQUIPMENT, AND TOOLS CALLED FOR IN THE JOB.
3. THE STUDENT WILL BE ABLE TO MAKE NECESSARY ADJUSTMENTS TO CAUSE THE DISTRIBUTOR BREAKER POINTS AND ENGINE TIMING TO FUNCTION AT PEAK PERFORMANCE; USING THE NECESSARY TOOLS, EQUIPMENT, AND SPECIFICATIONS CALLED FOR IN THE JOB.

**TOOLS AND EQUIPMENT:** CLEAN RAGS, CHALK, TIMING LIGHT, TACH-DWELL METER, ALLEN WRENCH, SCREWDRIVER, DISTRIBUTOR WRENCH, FENDER COVERS, SEAT COVER, DROP LIGHT

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** JOB AND TASK SHEETS

**REFERENCES:**
AUTOMECHANICS, PP. 308, 311-313
AUTOMOTIVE ENCYCLOPEDIA, P. 413
AUTO SERVICE AND REPAIR, PP. 21-15 TO 21-16, 21-21 TO 21-22
AUTOMOTIVE MECHANICS, PP. 365, 368

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST BE ABLE TO IDENTIFY THE PARTS OF AN IGNITION SYSTEM DISTRIBUTOR AND RECITE ITS FUNCTIONS. THE STUDENT MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS.

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. PREPARATIONS FOR THE JOB
3. TEST EQUIPMENT HOOKUP
4. ACCURACY OF TEST RESULTS
5. ACCURACY OF ADJUSTMENTS
6. SAFE WORKING HABITS
7. APPRECIATION FOR TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE ANGLE OF DWELL IS OFTEN REFERRED TO AS THE CAM ANGLE. THE ANGLE OF DWELL REFERS TO THE TOTAL TIME THAT THE POINTS ARE CLOSED, OR IT REFERS TO THE DISTANCE THAT THE DISTRIBUTOR CAM ROTATES, IN DEGREES, FROM THE TIME THE BREAKER POINTS CLOSE UNTIL THEY OPEN AGAIN. THE FIXED POINT CAP CONTROLS THE ANGLE OF DWELL; THEREFORE, BOTH MUST BE CONSIDERED TOGETHER. THE LARGER THE BREAKER POINT GAP THE SMALLER THE ANGLE OF DWELL. IN DISTRIBUTORS WITH A WINDOW IN THE CAP, THE ANGLE OF DWELL CAN BE SET WHILE THE ENGINE IS RUNNING. OTHER DISTRIBUTORS MUST HAVE THE CAP REMOVED BEFORE THE ANGLE OF DWELL CAN BE SET.

TIMING OF AN ENGINE IS A CRITICAL MECHANICAL ADJUSTMENT AS THE IGNITION TIMING AFFECTS POWER AND FUEL CONSUMPTION, AS WELL AS ENGINE OPERATING TEMPERATURE. TIMING ADJUSTMENTS ARE MADE BY MOVING THE DISTRIBUTOR. TIMING MARKS ARE USUALLY FOUND AT THE FRONT OF THE ENGINE ON THE VIBRATION DAMPER; HOWEVER, SOME OLDER MODEL VEHICLES HAVE TIMING MARKS ON THE FLYWHEEL, EITHER A STEEL BALL OR MARKINGS.

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | 1. AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | 1. AS IN PRECEDING TASKS |
| 3. PREPARE DISTRIBUTOR | 1. REMOVE CAP AS IN LESSON VIII-C-6(S)<br>2. REMOVE ROTOR CAP<br>3. CONNECT TACH - DWELL METER BETWEEN DISTRIBUTOR PRIMARY LEAD AND GROUND<br>4. POSITION TACH - DWELL METER DIAL WHERE IT CAN BE SEEN AS THE ENGINE IS TURNED OVER<br>5. HOOK UP REMOTE STARTER SWITCH |
| 4. SET ANGLE OF DWELL | 1. SET PARK BRAKE<br>2. PLACE TRANSMISSION IN NEUTRAL<br>3. USE REMOTE STARTER SWITCH<br>4. TURN ENGINE OVER SEVERAL TIMES<br>5. NOTE READING INDICATED ON TACH-DWELL METER<br>6. CHECK MANUFACTURER'S SPECIFICATIONS FOR DWELL SETTING |

7. LOOSEN BREAKER POINT LOCKING SCREWS JUST ENOUGH IN ORDER TO MOVE POINT ADJUSTMENT
8. TURN ENGINE OVER WITH STARTER USING REMOTE SWITCH
9. WATCH DWELL METER
10. ADJUST DWELL BY MOVING BREAKER POINT ADJUSTMENT
11. STOP ENGINE
12. TIGHTEN BREAKER POINT LOCKING SCREWS
13. TURN ENGINE OVER AND CHECK DWELL

NOTE: THERE ARE TIMES WHEN THE TIGHTENING OF BREAKER POINT LOCKING SCREWS WILL CHANGE THE ANGLE OF DWELL. IN THIS CASE IT WILL BE NECESSARY TO COMPENSATE FOR THIS IN POINT ADJUSTMENT BY EITHER ADDING A FEW DEGREES OF DWELL IN ONE DIRECTION OR THE OTHER WHEN THE POINT LOCKING SCREWS ARE LOOSE

5. TEST ANGLE OF DWELL

1. REPLACE ROTOR CAP
2. REPLACE DISTRIBUTOR CAP
3. START ENGINE
4. CHECK DWELL METER READING
5. INCREASE ENGINE SPEED TO 1500 RPM
6. CHECK DWELL METER READING

NOTE: FROM ENGINE IDLE SPEED TO 1500 RPM DWELL SHOULD NOT VARY MORE THAN 3 DEGREES. ANY VARIATION GREATER THAN 3 DEGREES INDICATES A FAULTY DISTRIBUTOR

7. STOP ENGINE

NOTE: DISTRIBUTOR WITH WINDOW, DWELL MAY BE SET WHILE ENGINE IS RUNNING

a. METER HOOKUP SAME AS STEP 3
b. RAISE WINDOW
c. INSERT ALLEN WRENCH IN ADJUSTING SCREW

   d. START ENGINE
   e. TURN ALLEN WRENCH TO ADJUST DWELL
   f. REMOVE ALLEN WRENCH AND TEST ANGLE OF DWELL

  8. SWITCH TACH-DWELL METER TO TACHOMETER

6. HOOK UP TIMING LIGHT

  1. CONNECT LOW TENSION WIRES ACROSS BATTERY
  2. CONNECT ONE HIGH-TENSION LEAD TO NUMBER ONE SPARK PLUG TERMINAL
  3. CONNECT SECOND HIGH-TENSION LEAD TO GOOD GROUND

7. PREPARE ENGINE FOR TIMING

  1. TURN CRANKSHAFT BY BUMPING STARTER
  2. OBSERVE FLYWHEEL OR HARMONIC BALANCE ON FRONT OF CRANKSHAFT
  3. STOP BUMPING ENGINE OVER WHEN IGNITION MARK APPEARS
  4. WIPE GREASE AND DIRT FROM TIMING MARKS AND POINTER WITH CLEAN RAG
  5. MARK TIMING MARK WITH NARROW BAND OF CHALK
  6. REMOVE DISTRIBUTOR VACUUM ADVANCE HOSE FROM CARBURETOR OR INTAKE MANIFOLD

     NOTE: THIS IS TO PREVENT THE VACUUM ADVANCE MECHANISM FROM OPERATING AND AFFECTING TIMING ADJUSTMENTS

  7. TAPE UP VACUUM HOLE IN CARBURETOR OR MANIFOLD

     NOTE: THIS IS TO PREVENT DRAWING AIR INTO THE MANIFOLD

  8. START ENGINE
  9. SET ENGINE IDLE AT 500 RPM OR LESS

     NOTE: THIS IS TO PREVENT DISTRIBUTOR MECHANICAL ADVANCE FROM OPERATING

8. SET TIMING
   1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT TIMING SETTING
   2. ENGINE IS TO CONTINUE RUNNING
   3. DIRECT LIGHT FROM BLINKING TIMING LIGHT ON FLYWHEEL OR HARMONIC BALANCE
   4. OBSERVE TIMING SETTING TO DETERMINE:
      a. ADVANCED TIMING
      b. RETARDED TIMING
      c. NEEDED AMOUNT OF ADJUSTMENT
   5. LOOSEN DISTRIBUTOR HOLD DOWN BOLT
   6. OBSERVE TIMING MARK
   7. TURN DISTRIBUTOR MOVING TIMING TO RECOMMENDED SPECIFICATIONS
   8. STOP ENGINE
   9. TIGHTEN DISTRIBUTOR HOLD DOWN BOLT
   10. START ENGINE RECHECK TIMING
   11. RESET ENGINE RPM TO SPECIFIED IDLE SPEED
   12. STOP ENGINE
   13. REMOVE TACH-DWELL METER
   14. REMOVE TIMING LIGHT
   15. REMOVE TAPE FROM VACUUM PORT
   16. RECONNECT DISTRIBUTOR VACUUM ADVANCE LINE

9. CLEAN WORK STATION
   1. AS IN PRECEDING TASKS

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## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PRACTICE ON TASKS UNDER CLOSE SUPERVISION.
2. STUDENTS TO USE JOB AND TASK SHEETS.
3. RETEACH IF THE NEED ARISES.

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## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON OWN.
2. USE PERFORMANCE TEST.
3. RECORD RESULTS ON PROGRESS CHART.

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY, HANDS CLEAR OF ENGINE MOVING PARTS, CLOTHING, JEWELRY.
2. MAKE SURE STUDENTS UNDERSTAND THE NEED FOR CRITICAL ADJUSTMENT.
4. EMPHASIZE FOLLOWING SPECIFICATIONS TO THE LETTER.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 285-288, 308-311
AUTOMOTIVE ENCYCLOPEDIA, PP. 407-417
AUTO SERVICE AND REPAIR, PP. 21-8 TO 21-22
AUTOMOTIVE MECHANICS, PP. 365-366, 369

THE NEXT LESSON IS: VIII-B-4(S) "SERVICE CARBURETOR AIR CLEANER"

VIII-B-3(J)

# JOB SHEET
IN
IGNITION SYSTEM

**JOB:** CHECK AND ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL AND TIMING

**MATERIALS:** CLEAN RAGS, TAPE

**TOOLS AND EQUIPMENT:** TACH - DWELL METER, TIMING LIGHT, DISTRIBUTOR WRENCH, DROP LIGHT, SCREWDRIVER, ALLEN WRENCH, FENDER COVERS, SEAT COVER

**GENERAL INSTRUCTIONS:** BEFORE BEGINNING THIS JOB READ REFERENCES. STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE OPERATING VEHICLE ENGINE AND TEST EQUIPMENT.

**PROCEDURE AND/OR TASKS:**

VIII-B-3(TS) ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL

VIII-B-3a(TS) ADJUST IGNITION TIMING

## TASK SHEET

VIII-B-3(TS)

**TASK:** ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL

**JOB:** CHECK AND ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL AND TIMING

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** TACH - DWELL METER, SCREWDRIVER, ALLEN WRENCH, FENDER COVERS, SEAT COVER, DROP LIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | 1. AS IN PRECEDING TASKS |
| 3. PREPARE DISTRIBUTOR | 1. REMOVE DISTRIBUTOR CAP AS IN JOB VIII-B-2(J)<br>2. REMOVE ROTOR CAP AS IN JOB VIII-B-2(J) |
| 4. CONNECT TACH-DWELL METER | 1. CONNECT POSITIVE LEAD<br>a. TO DISTRIBUTOR PRIMARY LEAD<br>b. EXPOSE PRIMARY TERMINAL ON COIL AND AFFIX LEAD<br>2. CONNECT NEGATIVE LEAD TO GOOD GROUND<br>3. POSITION DWELL METER DIAL WHERE IT CAN BE READ |
| 5. CONNECT REMOTE STARTER SWITCH | 1. ACROSS STARTER RELAY "OR"<br>2. BETWEEN BATTERY AND STARTER SOLENOID<br>3. POSITION SWITCH WHERE IT IS HANDY |
| 6. SET BREAKER POINTS ANGLE OF DWELL | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR DWELL SETTING<br>2. SET PARK BRAKE<br>3. PUT TRANSMISSION IN NEUTRAL<br>4. USE REMOTE STARTER SWITCH, TURN ENGINE OVER SEVERAL TIMES<br>5. NOTE READING ON DWELL METER<br>6. LOOSEN BREAKER POINT LOCKING SCREWS JUST ENOUGH TO BE ABLE TO MOVE POINT ADJUSTMENT |

| STEPS | KEY POINTS |
|---|---|
|  | 7. TURN ENGINE OVER AND MOVE POINTS WITH ADJUSTMENT |
|  | 8. WATCH DWELL METER AND SET DWELL NEEDLE ON RECOMMENDED DWELL BY ADJUSTING POINT GAP |
|  | NOTE: IN THE EVENT ADJUSTING THE POINTS DOES NOT GIVE THE SPECIFIED ANGLE OF DWELL THE POINTS COULD BE WRONG FOR THE DISTRIBUTOR OR THE CAM COULD BE WORN |
|  | 9. STOP ENGINE |
|  | 10. TIGHTEN BREAKER POINT LOCKING SCREWS |
|  | 11. TURN ENGINE OVER AND MAKE FINAL CHECK OF DWELL |
|  | NOTE: THERE ARE TIMES WHEN THE TIGHTENING OF BREAKER POINTS LOCKING SCREWS WILL CHANGE THE ANGLE OF DWELL. IN THIS CASE IT WILL BE NECESSARY TO COMPENSATE FOR THIS ERROR OF POINT ADJUSTMENT BY EITHER ADDING OR SUBTRACTING A FEW DEGREES OF DWELL WHEN MAKING THE DWELL ADJUSTMENT |
| 7. TEST ANGLE OF DWELL SETTING | 1. REPLACE ROTOR CAP |
|  | 2. REPLACE DISTRIBUTOR CAP |
|  | 3. REMOVE REMOTE STARTER SWITCH |
|  | 4. START ENGINE |
|  | 5. CHECK DWELL METER READING |
|  | 6. MOVE TACH-DWELL METER SELECTOR SWITCH TO TACHOMETER SIDE |
|  | 7. INCREASE ENGINE SPEED TO 1500 RPM |
|  | 8. MOVE TACH-DWELL METER SELECTOR SWITCH TO DWELL METER SIDE |
|  | 9. CHECK DWELL METER READING |
|  | NOTE: FROM ENGINE IDLE SPEED TO 1500 RPM DWELL SHOULD NOT VARY MORE THAN 3 DEGREES. ANY VARIATION GREATER THAN 3 DEGREES INDICATES A FAULTY DISTRIBUTOR |

| STEPS | KEY POINTS |
|---|---|
| | 10. STOP ENGINE<br>NOTE: DISTRIBUTOR WITH WINDOW IN CAP FOR ADJUSTING POINTS DWELL MAY BE SET WITH ENGINE RUNNING<br>a. DWELL METER HOOK UP SAME AS STEP 4<br>b. RAISE WINDOW<br>c. INSERT ALLEN WRENCH IN ADJUSTING SCREW<br>d. START ENGINE<br>e. TURN ALLEN WRENCH ADJUSTING DWELL<br>f. REMOVE ALLEN WRENCH<br>g. TEST ANGLE OF DWELL AS IN STEP 7<br>h. STOP ENGINE |

## TASK SHEET

VIII-B-3a(TS)

**TASK:** ADJUST IGNITION TIMING

**JOB:** CHECK AND ADJUST DISTRIBUTOR BREAKER POINT ANGLE OF DWELL AND TIMING

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SEAT COVER, FENDER COVER, TIMING LIGHT, TACH-DWELL METER, DISTRIBUTOR WRENCH, CLEAN RAGS, DROP LIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TIMING LIGHT | 1. CONNECT LOW-TENSION WIRES ACROSS BATTERY |
| | 2. CONNECT ONE HIGH-TENSION LEAD TO NUMBER ONE SPARK PLUG TERMINAL, MAKE SURE THERE IS A GOOD CONTACT |
| | 3. CONNECT SECOND HIGH-TENSION LEAD TO A GOOD GROUND |
| 2. PREPARE ENGINE FOR TIMING | 1. TURN CRANKSHAFT BY BUMPING STARTER |
| | 2. OBSERVE FLYWHEEL OR HARMONIC BALANCE ON FRONT OF CRANKSHAFT |
| | 3. STOP BUMPING ENGINE OVER WHEN TIMING MARK APPEARS |
| | 4. WIPE GREASE AND DIRT FROM TIMING MARK WITH CLEAN RAG |
| | 5. MARK TIMING MARK WITH NARROW BAND OF CHALK |
| | 6. REMOVE DISTRIBUTOR VACUUM ADVANCE HOSE FROM CARBURETOR OR INTAKE MANIFOLD |
| | NOTE: THIS WILL PREVENT THE DISTRIBUTOR VACUUM ADVANCE FROM OPERATING AND AFFECTING TIMING ADJUSTMENT |
| | 7. TAPE UP VACUUM HOLE IN CARBURETOR OR MANIFOLD |
| | NOTE: THIS IS TO PREVENT THE ENGINE FROM PULLING AIR INTO THE MANIFOLD CAUSING THE ENGINE TO RUN ROUGH |

| STEPS | KEY POINTS |
|---|---|
| | 8. MOVE TACH-DWELL METER INDICATOR SWITCH TO TACHOMETER POSITION |
| | 9. START ENGINE |
| | 10. SET ENGINE IDLE AT 500 RPM OR LESS<br>NOTE: THIS IS TO PREVENT DISTRIBUTOR MECHANICAL ADVANCE FROM OPERATING |
| | 11. STOP ENGINE |
| | 12. LOOSEN DISTRIBUTOR HOLD DOWN BOLT |
| 3. SET IGNITION TIMING | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT TIMING SETTING |
| | 2. START ENGINE |
| | 3. DIRECT LIGHT FROM TIMING LIGHT ON HARMONIC BALANCE |
| | 4. OBSERVE TIMING MARK |
| | 5. TURN DISTRIBUTOR MOVING TIMING MARK TO RECOMMENDED SPECIFICATIONS |
| | 6. STOP ENGINE |
| | 7. TIGHTEN DISTRIBUTOR HOLD DOWN BOLT |
| | 8. START ENGINE RECHECK TIMING |
| | 9. RESET ENGINE RPM TO RECOMMENDED SPECIFICATIONS |
| | 10. STOP ENGINE |
| | 11. REMOVE TACH-DWELL METER |
| | 12. REMOVE TIMING LIGHT |
| | 13. REMOVE TAPE FROM VACUUM PORT |
| | 14. INSTALL DISTRIBUTOR VACUUM ADVANCE LINE ON VACUUM PORT |
| 4. CLEAN WORK STATION | 1. AS IN PRECEDING TASKS |

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

VIII-B-6(I)

| | |
|---|---|
| SUBJECT: | CRANKCASE VENTILATION |
| AIM: | THE STUDENT WILL BE ABLE TO COMPARE CRANKCASE VENTILATION SYSTEMS AND DEFINE THEIR PURPOSE AND FUNCTION. |
| TEACHING AIDS: | TRANSPARENCIES: "GASOLINE ENGINES - DESCRIPTION, OPERATION, AND OVERHAUL", NO. 6003, FORD DIV., FORD MOTOR CO.<br>PVC |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, PP. 171-172, 328<br>AUTOMECHANICS, GLENN, P. 88-90<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 17<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, P. 100 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT SHOULD HAVE READ THE REFERENCES FOR THIS LESSON. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

FOR EVERY GALLON OF GASOLINE BURNED IN AN ENGINE, ABOUT A GALLON OF WATER IS FORMED BY THE COMBUSTION PROCESS. MOST OF IT GOES OUT THE EXHAUST, BUT SOME WATER VAPORS GET PAST THE PISTON RINGS AND DOWN INTO THE CRANKCASE. MIX THIS WATER VAPOR WITH OIL AND THE GASOLINE WHICH GETS BY THE RINGS THE SAME WAY, AND THE ENGINE NO LONGER HAS A GOOD LUBRICANT BUT A THICK, GUMMY SLUDGE WHICH GREATLY DECREASES ENGINE PERFORMANCE. THE METHOD USED TO AVOID THIS IS OUR TOPIC TODAY.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE OF VENTILATION | 1. WATER IS FORMED IN THE COMBUSTION PROCESS<br>a. BLOW-BY CARRIES WATER VAPOR PAST PISTON<br>b. MIXES WITH OIL TO FORM SLUDGE<br>2. COMBUSTION OF GASOLINE IS NEVER COMPLETE |

- a. CHOKING TO START COLD ENGINE LEAVES RAW GASOLINE
- b. GASOLINE ENTERS THE CRANKCASE AND THINS THE OIL

3. BEST SLUDGE PREVENTION IS REMOVAL OF WATER AND GASOLINE BEFORE REACTION TAKES PLACE
   - a. THIS IS PRIMARY FUNCTION OF VENTILATION SYSTEM
   - b. LONG DISTANCE DRIVING HEATS CRANKCASE OIL
   - c. WATER AND GASOLINE ARE BOILED OUT
   - d. VENTILATION OF CRANKCASE CARRIES VAPORS AWAY

B. TYPES OF SYSTEMS

1. OPEN SYSTEM

1. VENT TUBE SYSTEM ON OLDER ENGINES
   - a. ROAD-DRAFT SYSTEM OF VENTILATION
   - b. OPENING AT FRONT OF CRANKCASE ALLOWED AIR IN
   - c. TUBE IN BACK LET AIR OUT
     - (1) OPENING AT END SET AT ANGLE
     - (2) PASSING AIR CREATED VACUUM
2. SYSTEM EFFICIENT ONLY AT HIGH SPEED
   - a. NO VACUUM CREATED AT LOW SPEED
   - b. RELEASED VAPORS INTO ATMOSPHERE

2. CLOSED SYSTEM

1. SYSTEM ON MOST MODELS SINCE 1964
   - a. INTAKE MANIFOLD SUCKS IN VAPORS ON SOME MODELS
   - b. VACUUM CREATED BY AIR IN CARBURETOR DOES SAME ON OTHERS
   - c. VACUUM ACTUATES A CONTROL VALVE
     - (1) CALLED A POSITIVE CONTROL VALVE OR PVC
     - (2) VACUUM DROP OPENS VALVE
     - (3) ALLOWS CIRCULATION OF AIR THROUGH CRANKCASE
2. A POSITIVE TYPE VENTILATOR

3. SINCE 1968 HAS BEEN REQUIRED BY LAW

C. CRANKCASE EMISSION CONTROL

1. HOSE CONNECTS AIR BREATHER WITH OIL FILLER CAP
2. FILTERED AIR AND GASOLINE FUMES DRAWN INTO OIL PASSAGES OF ENGINE
3. CIRCULATES THROUGH ENGINE PICKING UP VAPORS
4. EXITS THROUGH HOSE CONNECTED TO VALVE COVER
5. PVC LOCATED IN HOSE ADJUSTS AIR FLOW
6. HOSE IS CONNECTED TO INTAKE MANIFOLD
7. VAPORS AND FUMES ARE BURNED IN CYLINDERS
8. EMISSION OF POLLUTANTS FROM BOTH CARBURETOR AND CRANKCASE CONTROLLED IN THIS WAY

D. PCV OPERATION

1. IDLE SPEED CREATES HIGH VACUUM IN INTAKE MANIFOLD
2. HIGH VACUUM CLOSES PCV VALVE REDUCING AIR FLOW
3. REDUCTION OF AIR GIVES BETTER AIR-FUEL RATIO FOR IDLE SPEED

E. SERVICE CONSIDERATIONS

1. VENTILATION SYSTEM PARTS NEED FREQUENT CLEANING
2. VALVE MAY BECOME CLOGGED WITH CARBON
   a. CAUSES PRESSURE IN CRANKCASE
   b. FORCES OIL OUT MAIN BEARINGS
3. VALVE MAY NOT SEAT OR CLOSE CAUSING POOR IDLE
4. CLEANING OR REPLACEMENT OF OIL FILLER CAP NECESSARY ON SOME OLDER MODELS

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK QUESTIONS TO STIMULATE CLASS DISCUSSION AND CHECK COMPREHENSION OF MATERIALS PRESENTED.

EXAMPLE: WHAT IS THE BEST WAY TO PREVENT SLUDGE FROM FORMING IN AN ENGINE CRANKCASE?

ANSWER: BY REMOVING THE AGENTS THAT REACT WITH OIL TO FORM SLUDGE, THE PROBLEM IS SOLVED BEFORE IT BEGINS. RUNNING AN ENGINE LONG ENOUGH TO HEAT THE OIL ABOVE THE BOILING POINTS OF WATER AND GASOLINE CAUSES THEM TO VAPORIZE. THE VAPOR IS THEN CARRIED OFF BY CIRCULATING AIR.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE TEST

1. A PINT OF WATER IS FORMED FOR EVERY GALLON OF GASOLINE THAT IS USED IN AN ENGINE. F
2. "BLOW-BY" REFERS TO WATER BEING CARRIED PAST THE PISTON. T
3. OVER-CHOKING A COLD ENGINE CAN THIN THE OIL IN THE CRANKCASE. T
4. RUNNING AN ENGINE FOR ONLY SHORT PERIODS CAN DECREASE ITS LUBRICATING EFFICIENCY. T
5. THE PRIMARY FUNCTION OF AN ENGINE VENTILATION SYSTEM IS TO REMOVE DUST AND GRIT FROM THE OIL. F
6. "ROAD-DRAFT" AND "VENT TUBE" WERE NAMES FOR THE SAME TYPE VENTILATION SYSTEM. T
7. ALL AMERICAN MADE CARS NOW HAVE CLOSED VENTILATION SYSTEMS. F
8. THE PCV IS OPERATED BY VACUUM. T
9. LOCATION OF THE PCV IS BETWEEN AIR BREATHER AND VENTILATION INLET. F
10. ENGINE EFFICIENCY MAY BE DIRECTLY RELATED TO THE CONDITION OF ITS VENTILATION SYSTEM. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

WATER IS A NATURAL PRODUCT FORMED IN THE COMBUSTION PROCESS.

SOME OF IT, ALONG WITH UNBURNED GASOLINE, GETS PAST THE PISTON RINGS DOWN INTO THE CRANKCASE. IF ALLOWED TO REMAIN THERE, THEY DILUTE THE OIL AND FORM A SLUDGE WHICH REDUCES ENGINE EFFICIENCY.

DURING LONG DRIVES ENGINE OIL IS HEATED ABOVE THE BOILING POINTS OF BOTH GASOLINE AND WATER. THEY ARE VAPORIZED AND REMOVED BY THE VENTILATION SYSTEM.

BEFORE AIR POLLUTION BECAME SUCH A PROBLEM IN LARGER CITIES, ENGINES WERE BUILT WITH A VENT-TUBE VENTILATION SYSTEM WHICH OPERATED ON A ROAD DRAFT PRINCIPLE. IT WAS, HOWEVER, INEFFICIENT AT LOW SPEEDS AND CONTRIBUTED TO AIR POLLUTION BY VENTING THE VAPORS INTO THE ATMOSPHERE.

AT PRESENT, LAW REQUIRES THAT ENGINES BEING MANUFACTURED HAVE CLOSED VENTILATION SYSTEMS THAT CONTROL BOTH CARBURETOR AND CRANKCASE EMISSIONS BY BURNING THEM IN THE CYLINDERS.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CH. 6

THE NEXT LESSON IS: VIII-B-7(I), "CARBURETOR AIR CLEANER"

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## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-B-7-(I)

| | |
|---|---|
| SUBJECT: | CARBURETOR AIR CLEANERS |
| AIM: | THE STUDENT WILL BE ABLE TO COMPARE VARIOUS METHODS USED IN CLEANING AIR FOR INTERNAL COMBUSTION ENGINES. |
| TEACHING AIDS: | TRANSPARENCIES: "GASOLINE ENGINES - DESCRIPTION, OPERATION, AND OVERHAUL", NO. 6003, FORD DIV., FORD MOTOR CO.<br>OIL BATH AND DRY TYPE AIR CLEANERS<br>CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, PP. 132, 334-335<br>AUTOMECHANICS, GLENN, 161-162<br>AUTO SERVICE AND REPAIR, STOCKEL, 20-30<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, 241-242 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT SHOULD HAVE READ THE REFERENCES FOR THIS LESSON. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

AN AUTOMOBILE ENGINE USES A GREAT DEAL OF AIR IN NORMAL OPERATION. IT MAY CONSUME AS MUCH AS A HUNDRED CUBIC FEET OF AIR FOR EVERY MILE THE CAR IS DRIVEN. CONSIDERING HOW MUCH THAT WOULD BE IN A THOUSAND MILES, AND THE AMOUNT OF DUST AND FLOATING PARTICLES IT MIGHT CONTAIN, WE CAN UNDERSTAND THE NEED FOR CLEANING THE AIR BEFORE IT ENTERS THE ENGINE. HOW THIS IS DONE IS THE SUBJECT OF TODAY'S LESSON.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE OF AIR CLEANER | 1. PRIMARY FUNCTION IS REMOVAL OF DUST AND GRIT FROM AIR |
| | 2. MUFFLES NOISE OF AIR RUSHING INTO CARBURETOR AIR HORN |
| | 3. ARRESTS FLAME WHEN ENGINE BACKFIRES THROUGH CARBURETOR |

B. TYPES

1. OIL SATURATED IS OLDER TYPE CLEANER
   - a. AIR GOES THROUGH FINE MESH SCREEN
   - b. SCREEN SATURATED WITH ENGINE OIL
   - c. DUST STICKS TO OILY SCREEN
   - d. NOT VERY EFFICIENT IN OPERATION
     - (1) MAY BECOME CLOGGED WITH DUST
     - (2) RESTRICTED AIR FLOW AFFECTS AIR-FUEL RATIO
     - (3) CAN RESULT IN POOR ENGINE PERFORMANCE
     - (4) ALLOWS SMALLER DUST PARTICLES THROUGH
   - e. REQUIRES FREQUENT SERVICE
     - (1) SCREEN WASHED IN SOLVENT
     - (2) DIPPED IN ENGINE OIL
     - (3) SERVICE RECOMMENDED EVERY 1,000 MILES OR SOONER
2. OIL BATH TYPE IS MORE EFFICIENT
   - a. AIR FORCED TO REVERSE DIRECTION OVER OIL POOL
   - b. MOST DUST PARTICLES FALL INTO OIL
   - c. AIR THEN PASSES THROUGH OIL SATURATED SCREEN
   - d. SILENCER REDUCES AIR NOISE
   - e. SERVICE RECOMMENDED EVERY 5,000 MILES
     - (1) SCREEN CLEANED AND CONDITIONED AS IN OIL SATURATED TYPE
     - (2) OIL BATH PART EMPTIED AND SCRAPED
     - (3) FILLED WITH 40 WEIGHT ENGINE OIL
3. PAPER ELEMENT TYPES ARE VERY EFFICIENT
   - a. FILTER IS COMPOSED OF SPECIAL PAPER
   - b. ACCORDIAN-LIKE FOLDS ALLOW MORE SURFACE AREA FOR AIR PAS-

SAGE

- c. PLASTIC RINGS SEAL TOP AND BOTTOM
- d. FILTER REMOVED FROM HOUSING AND CLEANED BY:
  - (1) TAPPING AGAINST HARD SURFACE
  - (2) BLOWING FROM INSIDE RING WITH AIR HOSE

NOTE: NEVER PLACE IN CLEANING SOLUTION

4. DUAL STAGE CLEANER FOR HEAVY DUTY USE
   - a. HAS OIL SATURATED PAPER INNER FILTER THAT IS REPLACEABLE
   - b. GLYCOL SATURATED OUTER FILTER COMPOSED OF POLYURETHANE FOAM
   - c. OUTER ELEMENT SERVICED EVERY 12,000 MILES
     - (1) WASHED IN CLEANING SOLVENT
     - (2) SATURATED WITH 30 WEIGHT OIL

CAUTION: POLYURETHANE TEARS EASILY. NEVER WRING OR SHAKE IT TO REMOVE EXCESS OIL

C. CLEANERS ON EMISSION CONTROLLED ENGINES

1. SOME AIR CLEANERS USED IN EMISSION CONTROL
2. HOSE CONNECTS AIR CLEANER WITH CRANKCASE BREATHER CAP
3. AIR TRAVELS THROUGH CLEANER INTO CRANKCASE
4. SERVICE OF AIR CLEANER INCLUDES HOSE OR TUBING AND FITTING INSPECTION
5. THIS IS CALLED "CLOSED" CRANKCASE

D. CONSTRUCTION

1. AIR CLEANERS ARE VARIABLE IN DESIGN
2. FILTERS USUALLY ENCLOSED IN HOUSING
3. REMOVABLE COVER ALLOWS ACCESS TO FILTER

4. HOUSING MAY BOLT TO SUPPORT BRACE
5. RING CLAMP ATTACHES HOUSING TO CARBURETOR

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATION OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

SHOW STUDENTS CARBURETOR AIR CLEANERS. DISASSEMBLE AND SHOW HOW FILTERS ARE CONSTRUCTED. DRAW DIAGRAM SHOWING AIR FLOW THROUGH HOUSING AND FILTER ON CHALKBOARD. SHOW TRANSPARENCIES AND DISCUSS.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED)

QUESTIONS: SIMPLE RECALL

1. WHY DOES AN ENGINE NEED AN AIR CLEANER?

   AN AUTOMOBILE USES ABOUT A HUNDRED CUBIC FEET OF AIR PER MILE, AND THE AIR HAS DUST AND GRIT IN IT. THESE ABRASIVES CAN CAUSE RAPID ENGINE WEAR IF THEY GET INTO THE CYLINDERS.

2. WHAT ARE THE FUNCTIONS OF AN AIR CLEANER?

   THE PRIMARY FUNCTION IS REMOVAL OF DUST AND GRIT FROM AIR GOING INTO THE ENGINE, BUT IT ALSO ACTS AS A MUFFLER AND FLAME ARRESTER.

3. DESCRIBE THE OLDER TYPE AIR CLEANER FOUND ON EARLY AUTOMOBILES.

   THE CLEANER HAD AN OIL SATURATED WIRE MESH SCREEN TO TRAP DUST PARTICLES. IT WAS ONLY FAIRLY EFFICIENT AND REQUIRED FREQUENT SERVICE.

4. WHY DID THE OIL BATH CLEANER REPLACE THE OLDER TYPE?

   IT DID A MUCH BETTER JOB OF CLEANING THE AIR AND REQUIRED LESS FREQUENT SERVICE.

5. WHAT ARE SOME ADVANTAGES OF A DRY PAPER FILTER?

   THEY ARE MUCH MORE EFFICIENT THAN THE OIL TYPE AND ARE EASILY CLEANED FOR REUSE.

6. DESCRIBE A DUAL STAGE OR HEAVY DUTY AIR CLEANER.

   THIS CLEANER HAS AN OIL SATURATED PAPER INNER FILTER AND A GLYCOL SATURATED FOAM OUTER FILTER.

7. HOW IS A POLYURETHANE FILTER SERVICED?

   IT IS REMOVED, WASHED IN SOLVENT, SATURATED WITH 30 WEIGHT OIL, AND RETURNED TO THE HOUSING.

8. EXPLAIN HOW AIR CLEANERS ARE USED IN EMISSION CONTROL.

   AIR GOING INTO THE CRANKCASE IS BROUGHT IN FROM THE AIR CLEANER THROUGH A HOSE.

9. WHAT ARE THE TWO MAIN COMPONENTS OF MOST AIR CLEANERS?

   MOST HAVE A FILTER ENCLOSED IN A HOUSING.

10. HOW ARE AIR CLEANERS SUPPORTED?

    THEY ATTACH TO THE CARBURETOR WITH A RING CLAMP AND MAY ALSO BOLT TO A BRACE SUPPORT.

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V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

DUE TO THE VOLUME OF AIR USED BY AN ENGINE AND THE FOREIGN PARTICLES IT CONTAINS, AIR CLEANERS ARE NECESSARY FOR EFFICIENT, LONG LASTING OPERATION.

SEVERAL TYPES OF AIR CLEANERS HAVE BEEN USED, BUT BECAUSE THEY WERE INEFFICIENT OR REQUIRED SERVICE TOO FREQUENTLY, MOST HAVE GIVEN WAY TO EITHER DRY FILTERS OR DUAL STAGE CLEANERS.

AIR CLEANERS ARE USED IN EMISSION CONTROL BY CONNECTING THEM WITH THE CRANKCASE BREATHER CAP. THIS DIRECTS AIR THROUGH THE FILTER BEFORE IT ENTERS THE CRANKCASE.

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, GLENN, PP. 88-90

THE NEXT LESSON IS: VIII-C-1(I), "BASIC FUNDEMENTALS OF ELECTRICITY"

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-B-4(S)

| | |
|---|---|
| TASK: | SERVICE CARBURETOR AIR CLEANER |
| AIM: | 1. STUDENT WILL BE ABLE TO DIAGNOSE AIR CLEANER PROBLEMS<br>2. STUDENT WILL BE ABLE TO REPAIR OR SERVICE ALL AIR CLEANERS |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS AND PARTS WASHER |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | MANUFACTURER'S SPECIFICATIONS |
| REFERENCES: | AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 253<br>AUTO SERVICE AND REPAIR, STOCKEL, 20-30 TO 20-33 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | MUST HAVE SUCCESSFULLY PASSED TEST ON: "CARBURETOR AIR CLEANERS" |
| CHECKING STANDARDS: | 1. SELECT THE PROPER TOOLS AND EQUIPMENT<br>2. MAINTAIN CRAFTSMANLIKE WORK<br>3. APPRECIATION FOR TOOLS, EQUIPMENT, AND AUTOMOBILE<br>4. FOLLOW STANDARD PROCEDURE AS SET FORTH BY THE INSTRUCTOR |

### I. PREPARATION (OF THE LEARNER - MOTIVATION)

1. WHY DOES AN ENGINE REQUIRE AN AIR CLEANER?
    a. PRIMARY FUNCTION IS REMOVAL OF DUST AND GRIT FROM AIR
    b. MUFFLE NOISE OR AIR RUSHING INTO CARBURETOR AIR HORN
    c. ARREST FLAME WHEN ENGINE BACK FIRES THROUGH CARBURETOR
2. HOW IS AIR CLEANED?
    a. OIL SATURATION IS THE OLDER TYPE OF CLEANER
    b. OIL BATH TYPE IS MORE EFFICIENT THAN OIL SATURATION
    c. PAPER TYPE IS THE MOST EFFICIENT

### II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. DEMONSTRATE | 1. STEP BY STEP<br>2. EMPHASIZE KEY POINTS<br>3. QUESTIONS STUDENTS AS DEMONSTRA- |

| | |
|---|---|
| | TION PROGRESSES<br>4. EMPHASIZE SAFETY AND CAUTIONS<br>5. STRESS CRAFTSMANSHIP |
| 2. REMOVE AIR CLEANER FROM VEHICLE | 1. REMOVE WING NUT ATTACHING AIR CLEANER BODY TO CARBURETOR<br>2. DISCONNECT CRANKCASE VENTILATION HOSE AT AIR CLEANER BODY<br>3. DISCONNECT VACUUM HOSE FOR AIR CLEANER VALVE<br>4. REMOVE AIR CLEANER AS AN ASSEMBLY<br>CAUTION: TO PREVENT DIRT FROM ENTERING CARBURETOR, ALWAYS REMOVE AIR CLEANER BODY FROM CARBURETOR BEFORE REMOVING AIR CLEANER ELEMENT |
| 3. REPLACE AIR CLEANER ASSEMBLY | 1. WASH AIR CLEANER BODY AND COVER IN CLEANING SOLVENT<br>CAUTION: NEVER WASH PAPER FILTER ELEMENT WITH ANYTHING<br>2. INSPECT FILTER ELEMENT AND REPLACE IF NEEDED<br>3. INSPECT VENTILATION FILTER AND REPLACE IF NEEDED<br>4. INSPECT CARBURTEOT THROAT GASKET AND REPLACE IF NEEDED<br>5. PLACE AIR CLEANER BODY ON CARBURETOR<br>NOTE: MAKE SURE AIR INTAKE DUCT AND HOT AIR INTAKE TUBE ARE PROPERLY ALIGNED<br>6. PLACE AIR FILTER ELEMENT IN AIR CLEANER BODY<br>NOTE: BE SURE TOP SIDE OF ELEMENT IS UP, COVER SIDE AND ELEMENT IS PROPERLY SEATED<br>7. PUSH VACUUM HOSE FOR AIR CLEANER VALVE AND CRANKCASE VENTILATING HOSE BACK ON RESPECTIVE FITTINGS<br>8. SECURE WING NUT ON COVER BOLT A TURN TO RIGHT (CLOCKWISE). TIGHTEN TO SPECIFICATIONS |
| 4. MAKE VEHICLE READY | 1. CONNECT BATTERY<br>2. REMOVE ALL TOOLS FROM VEHICLE |

## II. PRESENTATION (CON'T)

| | |
|---|---|
| | 3. MOVE VEHICLE TO PARKING AREA |
| 5. CLEAN WORK STATION | 1. CLEAN TOOLS AND RETURN TO STORAGE AREA<br>2. SWEEP WORK STATION<br>3. PICK UP AND PLACE RESIDUE IN TRASH<br>4. RETURN CLEANING EQUIPMENT TO STORAGE |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENT TO REPEAT ORALLY STEPS OF THE TASK.
2. CHECK STUDENTS FOR COMPREHENSION OF KEY POINTS.
3. CHECK STUDENTS FOR POINTS OF SAFETY.
4. STUDENTS TO PRACTICE ON TASK. USE JOB SHEET.

## IV. VERIFICATION AND/OR EVALUATION (CHECK OF STUDENTS' ABILITY)

PUT STUDENT ON THEIR OWN TO PERFORM TASKS.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

1. REPEAT EACH STEP FROM STAGE II AND EMPHASIZE PERTINENT POINTS.
2. REEMPHASIZE NEED FOR SAFETY.
3. STRESS POINTS CONCERNING CARE OF THE CUSTOMER'S PROPERTY.
4. EMPHASIZE CLEANLINESS WITH WORK.
5. REEMPHASIZE HIGHLIGHTS OF KEY POINTS.

SUGGESTED READING FOR STUDENTS:

AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 253
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-30 TO 20-33

THE NEXT LESSON IS: VIII-C-1(S) "TEST STORAGE BATTERY"

VIII-B-4(J)

# JOB SHEET
# IN
# FUEL SYSTEM

**JOB:** SERVICE CARBURETOR AIR CLEANER

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS AND 2 FENDER COVERS

**GENERAL INSTRUCTIONS:** BEFORE BEGINNING THE JOB THE STUDENT SHOULD REVIEW:
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, P. 253
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-30 TO 20-33

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-B-4(TS) | PREPARE VEHICLE |
| VIII-B-4a(TS) | REMOVE AIR CLEANER FROM VEHICLE |
| VIII-B-4b(TS) | REPLACE AIR CLEANER ASSEMBLY |
| VIII-B-4c(TS) | ADJUST FAST IDLE SPEED |
| VIII-B-4d(TS) | ADJUST CURB IDLE SPEED |
| VIII-B-4e(TS) | MAKE VEHICLE READY |
| VIII-B-4f(TS) | CLEAN WORK AREA |

**CHECKING STANDARDS:**

1. OBSERVATION OF PROTECTING PAINT ON VEHICLE
2. OBSERVATION OF SAFETY STANDARDS
3. USE OF TOOLS
4. TAKE MENTAL NOTES OF ALL NEW TASKS AT HAND

# TASK SHEET

VIII-B-4(TS)

TASK: PREPARE VEHICLE

JOB: SERVICE CARBURETOR AIR CLEANER

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BATTERY PLIERS AND SAFETY GOGGLES

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. START ENGINE<br>2. DRIVE VEHICLE INTO WORK AREA<br>3. ALIGN VEHICLE IN WORK AREA<br>a. USE ASSISTANT<br>b. HAVE ASSISTANT STAND CLEAR OF VEHICLE<br>4. PUT VEHICLE IN NEUTRAL<br>5. SET FOOT OR HAND BRAKE |
| 2. PERFORM VEHICLE SAFETY | 1. CAUTION: DISCONNECT NEGATIVE BATTERY CABLE<br>2. REMOVE POSITIVE CABLE<br>NOTE: USE BATTERY PLIERS OR PULLER IF NECESSARY |

VIII-B-4a(TS)

# TASK SHEET

**TASK:** REMOVE AIR CLEANER FROM VEHICLE

**JOB:** SERVICE CARBURETOR AIR CLEANER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FENDER COVERS, DROP LIGHT, AND SMALL ADJUSTABLE WRENCH

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE ATTACHING WING NUT | 1. TURN NUT TO LEFT (COUNTERCLOCKWISE)<br>2. PLACE NUT IN CONTAINER |
| 2. DISCONNECT CRANKCASE VENTILATION HOSE | 1. PULL AND TWIST HOSE, BY HAND, TO RELEASE FROM FITTING<br>2. COVER OPENING WHERE HOSE WAS CONNECTED |
| 3. DISCONNECT VACUUM HOSE FROM CARBURETOR | 1. PULL AND TWIST HOSE, BY HAND, TO RELEASE FROM FITTING<br>2. COVER OPENING WHERE HOSE WAS CONNECTED WITH SHOP TOWEL |
| 4. DISCONNECT AIR CLEANER FROM CARBURETOR | 1. LIFT AIR CLEANER ASSEMBLY FROM CARBURETOR<br>CAUTION: TO PREVENT DIRT FROM ENTERING CARBURETOR, ALWAY REMOVE AIR CLEANER AS AN ASSEMBLY<br>2. PLACE ASSEMBLY ON WORK BENCH |

## TASK SHEET

VIII-B-4b(TS)

| | |
|---|---|
| TASK: | REPLACE AIR CLEANER ASSEMBLY |
| JOB: | SERVICE CARBURETOR AIR CLEANER |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | CLEANING SOLVENT IN WASH PAN, CLEAN RAGS, SAFETY GOGGLES, PARTS WASHING BRUSH, AND SMALL ADJUSTABLE WRENCH |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. WASH PARTS | 1. WASH AIR CLEANER BODY AND COVER WITH CLEANING SOLVENT<br>NOTE: NEVER WASH PAPER FILTER ELEMENT WITH ANYTHING |
| | 2. WIRE BODY AND COVER DRY WITH CLEAN RAG |
| 2. INSPECT PARTS | 1. VISUALLY INSPECT FILTER ELEMENT<br>NOTE: REPLACE IF NEEDED |
| | 2. VISUALLY INSPECT VENTILATION FILTER<br>NOTE: REPLACE IF NEEDED |
| | 3. VISUALLY INSPECT CARBURETOR THROAT GASKET<br>NOTE: REPLACE IF NEEDED |
| 3. INSTALL AIR CLEANER ASSEMBLY | 1. POSITION AIR CLEANER BODY ON CARBURETOR<br>NOTE: MAKE SURE AIR INTAKE DUCT AND HOT AIR INTAKE TUBE ARE PROPERLY ALIGNED |
| | 2. PLACE AIR FILTER ELEMENT IN AIR CLEANER BODY<br>NOTE: MAKE SURE TOP SIDE OF FILTER ELEMENT IS UP AND ELEMENT IS PROPERLY SEATED |
| | 3. PUSH VACUUM HOSE FOR AIR CLEANER VALVE AND VENTILATION HOSE BACK ONTO THEIR RESPECTIVE FITTINGS |
| | 4. PLACE COVER ON AIR CLEANER BODY |
| | 5. SECURE WING NUT ON COVER BODY<br>a. TURN NUT TO RIGHT (CLOCKWISE)<br>b. TIGHTEN TO SPECIFICATIONS |

TASK SHEET VIII-B-4c(TS)

TASK: ADJUST FAST IDLE SPEED ON ONE BARREL CARBURETOR

JOB: INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, TACHOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE CARBURETOR | 1. COVER ALL VACUUM FITTINGS<br>a. USE TAPE TO COVER FITTINGS<br>b. APPLY TAPE SECURELY |
| | 2. CONNECT TACHOMETER<br>a. CONNECT POSITIVE LEAD TO NEGATIVE COIL LEAD<br>b. CONNECT NEGATIVE LEAD TO GROUND |
| | 3. OPEN THROTTLE AND CLOSE CHOKE |
| | 4. CLOSE THROTTLE |
| | 5. PLACE FAST IDLE SCREW ON HIGHEST SPEED STEP |
| | 6. MOVE FAST IDLE CAM UNTIL SCREW DROPS IN SECOND HIGHEST SPEED STEP |
| | 7. START ENGINE |
| 2. ADJUST FAST IDLE SPEED | 1. MOVE FAST IDLE ADJUSTING SCREW<br>a. TURN PROPER DIRECTION<br>b. SET RPM TO SPECIFICATIONS |
| | 2. CLOSE AND RELEASE CHOKE VALVE |

TASK SHEET VIII-B-4d(TS)

TASK: ADJUST CURB IDLE SPEED ON ONE BARREL CARBURETOR

JOB: INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, TACHOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE | 1. START ENGINE<br>2. CONNECT TACHOMETER<br>a. CONNECT POSITIVE LEAD TO NEGATIVE COIL LEAD<br>b. CONNECT NEGATIVE LEAD TO GROUND |
| 2. ADJUST CARBURETOR | 1. RELEASE FAST IDLE CAM<br>2. MOVE IDLE SPEED ADJUSTING SCREW<br>a. TURN IN PROPER DIRECTION<br>b. SET ENGINE RPM TO SPECIFICATIONS |

# TASK SHEET

VIII-B-4e(TS)

**TASK:** MAKE VEHICLE READY

**JOB:** SERVICE CARBURETOR AIR CLEANER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BATTERY PLIERS OR BATTERY CLAMP PULLER AND CLEAN WIPING RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CONNECT BATTERY | 1. CONNECT POSITIVE CABLE<br>NOTE: INSPECT POST AND CLAMP. CLEAN IF NECESSARY<br>2. TIGHTEN CLAMP FIRMLY<br>3. CONNECT NEGATIVE CABLE<br>NOTE: INSPECT POST AND CLAMP. CLEAN IF NECESSARY<br>4. TIGHTEN CLAMP FIRMLY |
| 2. REMOVE TOOLS | 1. REMOVE COVERS FROM FENDERS<br>2. FOLD COVERS FOR STORING<br>3. RETURN COVERS TO STORAGE AREA<br>4. INSPECT CAR FOR TOOLS |
| 3. RETURN VEHICLE TO PARKING AREA | 1. WIPE FENDERS OF ANY GREASE OR DIRT CAUSED BY WORK PERFORMED<br>2. START ENGINE<br>3. REMOVE FROM WORK AREA<br>CAUTION: USE AN ASSISTANT WHEN BACKING UP FOR SAFETY PURPOSES<br>4. RETURN TO PARKING AREA<br>5. RETURN CAR KEYS TO INSTRUCTOR |

## TASK SHEET

**TASK:** CLEAN WORK AREA

**JOB:** SERVICE CARBURETOR AIR CLEANER

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FLOOR BROOM, AND DUST PAN

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. SECURE TOOLS | 1. PICK UP ALL TOOLS USED<br>2. WIPE TOOLS CLEAN<br>3. RETURN TO TOOL STORAGE |
| 2. SECURE WORK AREA | 1. PLACE ALL TRASH IN DISPOSAL CANS<br>2. SWEEP WORK AREA CLEAN<br>3. PICKUP DIRT AND RESIDUE IN DUST PAN<br>4. PLACE DIRT AND RESIDUE IN DISPOSAL CANS<br>5. RETURN BROOM AND DUST PAN TO STORAGE AREA |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-1(I)

**SUBJECT:** BASIC FUNDAMENTALS OF ELECTRICITY

**AIM:** THE STUDENT WILL BE ABLE TO DISCUSS AND APPLY THE BASIC FUNDAMENTALS OF ELECTRICITY IN ESTABLISHING AND MAINTAINING SIMPLE ELECTRIC CIRCUITS.

**TEACHING AIDS:** TRANSPARENCIES I. ED. II 7, T, FIGURES 169-186

**REFERENCES:** INTRODUCTION TO ELECTRICITY AND ELECTRONICS
LOPER AND AHR, CHS. 1, 2, 6
FUNDAMENTALS OF ELECTRICITY
GRAHAM, CHS. 1, 2, 5

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENT TO HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSONS.

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## I. PREPARATION (OF THE LEARNER)

ASK QUESTION: "WHAT IS THE GREATEST LUXURY IN THE WORLD TODAY?" (ALLOW STUDENTS A FEW MOMENTS TO THINK ABOUT IT).

CALL FOR ANSWERS AND LIST ON CHALKBOARD. (INTENDED ANSWER: ELECTRICITY!)

ASK QUESTION: "WHAT IS ELECTRICITY?" (ALLOW SEVERAL STUDENTS TO ANSWER).

EXPLAIN TO STUDENTS THAT NO ONE KNOWS WHAT IT IS, BUT WE KNOW HOW IT IS (HOW IT WORKS), AND THAT IS WHAT WE ARE GOING TO STUDY.

---

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. BASIS OF ELECTRICITY | NOTE: TO STUDY ELECTRICITY IN ITS MOST BASIC FORM WE MUST STUDY MATTER ITSELF |
| 1. MATTER | 1. MATTER IS ANYTHING WHICH HAS WEIGHT AND OCCUPIES SPACE<br>2. MATTER EXISTS IN THREE STATES:<br>a. SOLID (EXAMPLE: EARTH)<br>b. LIQUID (EXAMPLE: OCEANS)<br>c. GASEOUS (EXAMPLE: ATMOSPHERE)<br>3. MATTER CAN BE CHANGED FROM ONE STATE TO ANOTHER |

4. ALL MATTER CAN BE BROKEN DOWN INTO VERY SMALL PARTICLES CALLED MOLECULES
5. MOLECULES CAN BE BROKEN DOWN FURTHER INTO ATOMS
6. FOR MANY YEARS SCIENTISTS BELIEVED THE ATOM TO BE THE SMALLEST PARTICLE IN NATURE

2. ELECTRON THEORY

TRANSPARENCY
FIG. 169, 170

1. ATOMS, IT WAS DISCOVERED, WERE COMPOSED OF STILL SMALLER PARTICLES
2. THESE PARTICLES ARE ARRANGED SIMILAR TO OUR SOLAR SYSTEM
   a. PROTONS AND NEUTRONS COMPOSE THE NUCLEUS OR CORE; LIKE OUR SUN
   b. ELECTRONS ORBITING ABOUT THE NUCLEUS SIMILAR TO PLANETS ORBITING ABOUT THE SUN
3. THESE PROTONS AND ELECTRONS HAVE AN ATTRACTION FOR EACH OTHER AND THIS IS THE BASIS OF ELECTRICITY

   NOTE: SINCE NEUTRONS DO NOT ENTER INTO THE ELECTRON THEORY, THERE WILL BE NO FURTHER MENTION OF THEM. NEUTRONS SIMPLY ADD TO ATOMIC WEIGHT

   a. PROTONS ARE SAID TO HAVE A PLUS (+) CHARGE
   b. ELECTRONS ARE SAID TO HAVE A NEGATIVE (-) CHARGE
   c. NEUTRONS, PART OF NUCLEUS, HAVE NO CHARGE; ARE NEUTRAL

B. FUNDAMENTALS OF ELECTRICITY

TRANSPARENCIES
FIGS. 171, 172

1. ATOMS VARY GREATLY IN SIZE - THE NUMBER OF ELECTRONS AND PROTONS

   EXAMPLE:

   HYDROGEN - HAS (1) PROTON AND (1) ELECTRON

   ALUMINUM - HAS (13) PROTONS AND (13) ELECTRONS

   URANIUM - HAS (92) PROTONS AND (92) ELECTRONS

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2. SEVERAL ELECTRONS MAY SHARE THE SAME ORBITAL DIAMETER - BUT NOT THE SAME ORBITAL PATH

1. FORCE OF ATTRACTION

1. THE CORE EXERTS A PULLING FORCE ON THE ELECTRONS - THIS IS KNOWN AS A FORCE OF ATTRACTION
2. THIS FORCE OF ATTRACTION IS WHAT HOLDS THE ELECTRONS IN THEIR ORBIT
   - a. THIS ATTRACTION IS STRONGER ON ELECTRONS IN ORBITS CLOSER TO THE CORE THAN THOSE FARTHER AWAY
   - b. THIS ATTRACTION IS LEAST ON ELECTRONS IN OUTER ORBITS

TRANSPARENCY
FIG. 173

   - c. ELECTRONS IN INNER ORBITS FIRMLY HELD ARE TERMED PLANETARY ELECTRONS
   - d. LOOSELY HELD ELECTRONS IN OUTER ORBITS SOMETIMES ESCAPE THE ATTRACTION OF THE CORE AND ARE TERMED FREE ELECTRONS

2. ELECTRON FLOW

1. AN ATOM THAT LOSES AN ELECTRON TRIES TO ATTRACT ANOTHER ONE TO REPLACE THE ONE LOST
   - a. THIS ATTRACTING FORCE IS THE POSITIVE (+) CHARGE
   - b. THE NEUTRALIZING FORCE, SUPPLIED BY THE ELECTRON IN THIS ATTRACTION IS THE NEGATIVE (-) CHARGE
2. ELECTRICITY IS THE TERM APPLIED TO THE FORCE THAT RESULTS WHEN FREE ELECTRONS TRY TO NEUTRALIZE THEMSELVES - THE MOVEMENT OR FLOW OF ELECTRONS

C. ELECTRICAL CURRENT

NOTE: CONTROLLED MOTION (MOVEMENT) OF ELECTRONS IS ELECTRICAL CURRENT, AS WE SHALL STUDY IT

1. CHARGES

1. ELECTRICAL CHARGES AT REST ARE TERMED STATIC
2. ELECTRICAL CHARGES IN MOTION ARE TERMED DYNAMIC

| | |
|---|---|
| TRANSPARENCY FIG. 174 | 3. A MATERIAL WHICH IS CHARGED, EITHER NEGATIVELY OR POSITIVELY, IS SAID TO BE IONIZED |
| 2. INSULATORS AND CONDUCTORS | 1. MATERIALS WHOSE ATOMS CONTAIN LOOSELY BOUND ELECTRONS IN THEIR OUTER ORBITS THAT CAN BE EASILY FORCED OUT OF THEIR ORBIT, ARE SAID TO BE GOOD CONDUCTORS OF ELECTRICITY. COPPER IS ONE SUCH MATERIAL |
| | 2. MATERIALS WHOSE OUTER ELECTRONS ARE TIGHTLY BOUND AND DIFFICULT TO MOVE ARE SAID TO BE GOOD INSULATORS OF ELECTRICITY. PLASTICS AND RUBBER ARE SUCH EXAMPLES |
| 3. VOLTAGE | 1. A FORCE APPLIED TO ONE END OF A CONDUCTOR THAT CAN MAKE LOOSELY BOUND ELECTRONS MOVE IS CALLED VOLTAGE |
| TRANSPARENCY FIG. 175 | a. FORCE KNOCKS ELECTRONS OUT OF ORBIT |
| | b. FREE ELECTRONS SEEK OTHER ATOMS TO JOIN |
| | c. IN JOINING OTHER ATOMS, ELECTRONS KNOCK OTHER ELECTRONS FROM THEIR ORBIT, SETTING UP A CHAIN REACTION |
| | 2. THE GREATER THE VOLTAGE, THE MORE ELECTRONS FLOW, THE GREATER THE CURRENT |
| | 3. VOLTAGE APPLIED ACROSS THE ENDS OF A CONDUCTOR ATTACHED TO TWO TERMINALS WILL ATTRACT ELECTRONS TO THE POSITIVE TERMINAL AND REPEL THEM FROM THE NEGATIVE TERMINAL |
| | 4. THE DIRECTION OF CURRENT IS FROM NEGATIVE TO POSITIVE |
| D. MAGNETISM | 1. MAGNETISM AND ELECTRICITY ARE CLOSELY RELATED |
| | 2. ALL MAGNETISM IS ELECTROMAGNETISM |
| | a. THE EFFECT IS PRODUCED BY THE ENERGY OF THE FLOW OF ELECTRONS |

b. A MAGNETIC FIELD IS PRODUCED BY A MOVING ELECTRIC FIELD

1. BACKGROUND

1. A BLACK MINERAL WAS FOUND WHICH WOULD ATTRACT SMALL PIECES OF IRON
    a. FOUND OVER 2,000 YEARS AGO
    b. IN A COUNTRY CALLED MAGNESIA, IN ASIA MINOR
2. SUSPENDED, THIS MINERAL WILL ALSO ALIGN ITSELF IN A NORTH - SOUTH DIRECTION
    a. EARLY GREEK MARINERS USED THIS MINERAL TO INDICATE DIRECTIONS AT SEA
    b. CALLED THE MINERAL "LODESTONE" MEANING LEADING STONE
3. EARTH IS KNOWN TO BE A HUGE MAGNET WITH TWO MAGNETIC POLES; ONE LOCATED IN THE ARCTIC NEAR THE GEOGRAPHIC NORTH POLE; THE OTHER LOCATED IN THE ANTARCTIC NEAR THE GEOGRAPHIC SOUTH POLE

    NOTE: THE WORLD "POLE" MEANS "OPPOSITE PART" OR "OPPOSITE END"

2. LINE OF FORCE

TRANSPARENCIES
FIGS. 176, 177, 178

1. EMERGE FROM THE POLE IN ANTARCTICA, ARC AROUND THE EARTH, AND CONVERGE ON THE POLE IN THE ARCTIC
    a. THIS INDICATES THAT THE OPPOSITE POLES ATTRACT EACH OTHER
    b. CONVERSELY, LIKE POLES REPEL EACH OTHER
2. HAVE A DEFINITE DIRECTION - THAT WHICH THE ARROW OF A COMPASS POINTS
3. NEVER CROSS BECAUSE AN ARROW CAN POINT IN ONLY ONE DIRECTION AT A TIME
4. MAGNETIC MATERIALS ALIGN THEMSELVES WITH MAGNETIC LINES OF FORCE
    a. HENCE; LINES OF FORCE RUNNING IN THE SAME DIRECTION "ATTRACT"
    b. CONVERSELY, LINES OF FORCE RUNNING IN OPPOSITE DIRECTIONS

SEC

"REPEL"

5. BY DESCRIPTION THE END OF A MAGNET OR COMPASS POINTING NORTH IS CALLED ITS NORTH POLE

3. FIELD OF FORCE

1. THE SPACE AFFECTED BY A MAGNETIC FORCE; THE LINES OF FORCE
2. THE EXTENT OF THE FIELD OF FORCE IS DETERMINED BY THE STRENGTH (CONCENTRATION) OF THE LINES OF FORCE

   NOTE: DEMONSTRATE VARIOUS FIELDS OF FORCE WITH MAGNETS, STEEL FILINGS, AND POSTER BOARD
3. NON - MAGNETIC MATERIALS CANNOT INTERRUPT THIS FIELD OF FORCE
   a. WILL PENETRATE ALL NON-MAGNETIC MATERIALS
   b. IS AFFECTED ONLY BY OTHER MAGNETIC MATERIALS AND ELECTRICITY

E. ELECTROMAGNETISM
TRANSPARENCIES
FIG. 179, 180

1. AN ELECTRIC CURRENT PRODUCES A MAGNETIC FIELD OF FORCE ABOUT IT
   a. FIELD OF FORCE IS AT RIGHT ANGLE WITH CURRENT FLOW
   b. LINES OF FORCE WITHIN FIELD ORBIT ABOUT THE WIRE
2. DIRECTION OF FIELD OF FORCE CAN BE DETERMINED IF THE DIRECTION OF CURRENT IS KNOWN
3. LEFT HAND RULE
   a. PRETEND TO GRASP WIRE IN LEFT HAND WITH THUMB POINTING IN DIRECTION OF ELECTRICAL CURRENT FLOW
   b. FINGERS WILL POINT IN THE DIRECTION OF FLOW OF MAGNETIC FIELD OF FORCE

1. COILS

1. WHEN A WIRE CARRYING ELECTRIC CURRENT IS COILED, THE MAGNETIC FIELD OF FORCE ORBITING THE WIRE BECOMES CONCENTRATED ON INSIDE OF THE COIL

TRANSPARENCIES
FIGS. 181, 182, 183
184, 185, 186

2. AS COILED WIRE IS TIGHTENED, MAGNETIC FORCE FIELDS BECOME SO CONCENTRATED THEY INTERRUPT EACH

OTHER AND COMBINE TO MAKE A CONTINUOUS FIELD OF FORCE WHICH FLOWS THROUGH ENTIRE COIL

3. THE ENDS OF THE COIL, IN EFFECT, BECOME MAGNETIC POLES AND THE COIL A MAGNET
4. THE MAGNETIZING ABILITY OF A COIL IS INCREASED TREMENDOUSLY BY INSERTING A CORE INTO COIL OF A MAGNETIZING SUBSTANCE
5. THIS ABILITY OF A MAGNETIC MATERIAL TO INCREASE THE STRENGTH OF A FIELD OF FORCE IS CALLED PERMEABILITY

2. SOLENOIDS

1. WHEN A BATTERY CIRCUIT IS CLOSED AND A CURRENT STARTS, AS IN STARTING A CAR:
   - a. ELECTRONS ARE SET IN MOTION BY POTENTIAL ENERGY STORED IN THE BATTERY
   - b. THIS ENERGY (MOVEMENT OF ELECTRONS) IS NOT SUFFICIENT ALONE TO START A CAR
   - c. PASSED THROUGH A SPECIAL COIL (SOLENOID) THE ENERGY OF THE MAGNETIC FIELD AMPLIFIES THE ELECTRIC CURRENT
2. THE MAGNITUDE OF THIS AMPLIFICATION DEPENDS ON SEVERAL THINGS
   - a. AMOUNT OF CURRENT
   - b. NUMBER OF COILS
   - c. TYPE OF MATERIAL OF CONDUCTOR AND CORE

NOTE: THIS WILL BE STUDIED LATER IN ELECTRICAL MEASUREMENTS

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION)

ASSIGNMENT SHEET VIII-C-2(A) (PASSOUT FOR CLASS TO COMPLETE)

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

QUESTIONS (TRUE-FALSE)

1. MATTER CAN BE CHANGED FROM ONE STATE TO ANOTHER. T
2. ALL MATTER IS COMPOSED OF SMALL PARTICLES CALLED ATOMS. F
3. ATOMS ARE THE SMALLEST PARTICLE IN NATURE. F
4. NEUTRONS HAVE NO EFFECT ON AN ATOM. F
5. PROTONS ARE SAID TO CARRY A POSITIVE (+) CHARGE. T
6. ATOMS ARE ARRANGED SIMILAR TO OUR GALAXY. F
7. SEVERAL ELECTRONS MAY SHARE THE SAME ORBITAL PATH. F
8. THE ELECTRONS OF A HYDROGEN ATOM ARE LOOSELY HELD. F
9. THE CORE OF ATOMS EXERTS A PULLING FORCE ON ELECTRONS. T
10. ELECTRONS HELD FIRMLY IN ORBIT ARE TERMED PLANETARY. T
11. ELECTRICITY IS THE FLOW OF ELECTRONS. T
12. ELECTRICAL CHARGES IN MOTION ARE TERMED STATIC. F
13. MATERIALS WHICH DO NOT ALLOW ELECTRON MOVEMENT ARE CALLED INSULATORS. T
14. THE FORCE THAT CAUSES ELECTRONS TO MOVE IS CALLED VOLTAGE. T
15. THE GREATER THE VOLTAGE, THE GREATER THE CURRENT. T
16. THE DIRECTION OF CURRENT IS FROM POSITIVE TO NEGATIVE. T
17. AN ELECTRIC CURRENT PRODUCES A MAGNETIC FIELD ABOUT IT. F
18. AN IRON CORE IN A COILED LIVE WIRE INCREASES THE FORCE IN THE MAGNETIC FIELD. T
19. A MAGNETIC FIELD OF FORCE PENETRATES NON-MAGNETIC MATERIALS. T
20. PERMANENT MAGNET MATERIALS ARE OF MORE IMPORTANCE THAN TEMPORARY MAGNET MATERIALS. T
21. THE MAGNETIC FIELD OF AN ELECTRIC WIRE, WHOSE CURRENT FLOW IS DIRECTLY TOWARD YOU, WOULD TRAVEL COUNTERCLOCKWISE AROUND THE WIRE. F
22. THE ENDS OF AN ELECTRIC COIL ACT AS THE POLES OF A MAGNET. F

## IV. VERIFICATION (CON'T.)

23. ALL MATERIALS CAN BE ELECTRICALLY CHARGED. T

24. LIKE CHARGES ATTRACT; UNLIKE CHARGES REPEL. F

25. A COMPLETE CONDUCTING PATH MUST EXIST FOR ELECTRONS TO FLOW STEADILY. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS)

MATTER IS ANYTHING WHICH HAS WEIGHT AND OCCUPIES SPACE. MATTER EXISTS IN THREE STATES -- SOLID, LIQUID, GASEOUS, AND CAN BE CHANGED FROM ONE STATE TO ANOTHER.

ALL MATTER IS COMPOSED OF SMALL PARTICLES CALLED MOLECULES, AND MOLECULES ARE COMPOSED OF STILL SMALLER PARTICLES CALLED ATOMS. ATOMS ARE THE SMALLEST PART OF AN ELEMENT. MOLECULES ARE THE SMALLEST PART OF A COMPOUND.

ATOMS ARE COMPOSED OF VARIOUS NUMBERS OF PROTONS, ELECTRONS, AND NEUTRONS. THE NUMBER OF PROTONS DETERMINES THE TYPE ELEMENT. PROTONS ARE POSITIVE (+) CHARGES, HEAVY, AND COMPOSE THE NUCLEUS OF THE ATOM. NEUTRONS CARRY NO CHARGE, ARE A PART OF THE NUCLEUS, AND SIMPLY ADD TO THE ATOMIC WEIGHT. ELECTRONS ARE NEGATIVE (-) CHARGES, LIGHTWEIGHT, MOVABLE.

ELECTRICITY IS EXPLAINED BY THE BEHAVIOR OF ELECTRONS. ELECTRONS AND PROTONS HAVE A NATURAL ATTRACTION FOR EACH OTHER, THIS FORCE OF ATTRACTION HOLDS ELECTRONS IN ORBITS AROUND THE PROTONS. THIS ATTRACTION IS WEAKEST ON ELECTRONS IN THE OUTER ORBIT, AND THESE ELECTRONS ARE EASILY KNOCKED OUT OF THE ORBIT. THESE ARE TERMED FREE ELECTRONS. OTHER ELECTRONS HELD FIRM IN THEIR ORBIT ARE TERMED PLANETARY ELECTRONS. FREE ELECTRONS SEEK OTHER ATOMS TO JOIN.

A NEGATIVE - CHARGED OBJECT IS ONE THAT HAS GAINED ELECTRONS. A POSITIVE CHARGED OBJECT IS ONE THAT HAS LOST ELECTRONS. CHARGED OBJECTS ARE SAID TO BE IONIZED. LIKE CHARGES REPEL; UNLIKE CHARGES ATTRACT. ALL MATERIALS CAN BE ELECTRICALLY CHARGED. CHARGED OBJECTS ARE SURROUNDED BY AN ELECTRIC FIELD.

THE TERM ELECTRICITY IS APPLIED TO THE FORCE THAT RESULTS WHEN FREE ELECTRONS TRY TO NEUTRALIZE THEMSELVES.

CONTROLLED MOVEMENT OF ELECTRONS IS CALLED CURRENT. MATERIALS WHOSE ELECTRONS ARE EASILY MOVED ARE CALLED CONDUCTORS, AND MATERIALS WHOSE ELECTRONS RESIST MOVEMENT ARE CALLED INSULATORS.

A FORCE APPLIED TO A CONDUCTOR CAUSING THE MOVEMENT OF ELECTRONS IS CALLED VOLTAGE. THE GREATER THE VOLTAGE, THE MORE ELECTRONS FLOW, THE GREATER THE CURRENT. THE DIRECTION OF CURRENT FLOW IS FROM NEGATIVE TO POSITIVE. A COMPLETED PATH FROM ONE TERMINAL TO ANOTHER IS CALLED A CIRCUIT.

ELECTRICITY AND MAGNETISM ARE CLOSELY RELATED. MAGNETISM RESULTS FROM ELECTRON MOTION; THEREFORE, ALL MAGNETISM IS ELECTROMAGNETISM.

THE STRENGTH OF A MAGNETIC FIELD IS REPRESENTED BY THE DENSITY OF ITS LINE OF FORCE. THE DIRECTION OF A MAGNETIC FIELD IS THE DIRECTION WHICH THE NORTH POLE OF A COMPASS POINTS. MAGNETIC FIELDS OF FORCE ARE GREATER NEARER THE POLES WHERE LINES OF FORCE EMERGE AND CONVERGE. LINES OF FORCE RUN FROM NEGATIVE TO POSITIVE OR FROM NORTH POLE TO SOUTH POLE. LIKE POLES REPEL; UNLIKE POLES ATTRACT.

MOVING ELECTRONS EXERT A FORCE ON MAGNETS; MAGNETS EXERT A FORCE ON ELECTRONS. A WIRE PASSING ELECTRICAL CURRENT CREATES A MAGNETIC FIELD ORBITING ABOUT AND 90 DEGREES TO THE WIRE. A COILED WIRE CONCENTRATES THE FIELD OF FORCE ON THE INSIDE OF THE COILS. A MAGNETIC MATERIAL INJECTED INTO THIS TYPE COIL AMPLIFIES THE LINES (FIELD) OF FORCE. THIS TYPE COIL IS CALLED A SOLENOID.

THE STRENGTH OF A COIL DEPENDS ON THE VOLTAGE, THE NUMBER OF COILS, AND THE MATERIAL TYPE OF THE CORE. THE ABILITY OF A MATERIAL TO BECOME MAGNETIZED IS CALLED PERMEABILITY. THE UNWILLINGNESS OF A MATERIAL TO BECOME MAGNETIZED IS CALLED RELUCTANCE.

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SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, CH. 7

THE NEXT LESSON IS: VIII-C-2(I) "ELECTRIC CURRENTS AND MEASUREMENTS"

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

VIII-C-2(I)

| | |
|---|---|
| SUBJECT: | ELECTRIC CURRENTS AND MEASUREMENTS |
| AIM: | THE STUDENT WILL BE ABLE TO EXPLAIN THE DIFFERENT TYPES OF CURRENT AND USE OHM'S LAW IN CALCULATING VOLTAGE, RESISTANCE, AND AMPERAGE. |
| TEACHING AIDS: | FILMSTRIP NO. 3000-306-FSR1, "ELECTRICAL CIRCUIT FUNDAMENTALS", FORD MOTOR CO.; TRANSPARENCIES I. ED. II 7T, FIGURES 186-188 |
| MATERIALS: | CHALK |
| REFERENCES: | INTRODUCTION TO ELECTRICITY AND ELECTRONICS, CHS. 2 AND 4 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT TO HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSON VIII-C-1(I) BASIC FUNDAMENTALS OF ELECTRICITY |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

AS WE MENTIONED IN THE PREVIOUS LESSON, CURRENT IS THE MOVEMENT, OR FLOW, OF ELECTRONS, AND AS WE WILL STUDY IT, THE CONTROLLED FLOW OF ELECTRONS. THIS DOES NOT MEAN JUST TO CONTROL ITS PATH OR DIRECTION, BUT ALSO ITS INTENSITY AND STRENGTH. MANY FACTORS ENTER INTO THIS CONTROL OF ELECTRICITY, SUCH AS TYPE AND SIZE OF CONDUCTOR, ITS WILLINGNESS OR UNWILLINGNESS TO PASS ELECTRONS (RESISTANCE), THE ELECTROMOTIVE FORCE OR PRESSURE (VOLTAGE), AND THE RATE OF FLOW, WHICH IS CALLED AMPERAGE. IN ORDER TO CONTROL CURRENT, THESE THINGS MUST BE MEASURED, AND THIS IS OUR LESSON FOR TODAY.

AN EARLY MEASUREMENT OF CURRENT, CALLED THE COULOMB, WAS THE NUMBER OF ELECTRONS PASSING A GIVEN POINT IN ONE SECOND. ALTHOUGH THIS VALUE IS NOT USED IN PRACTICAL APPLICATION, IT IS INTERESTING TO NOTE ITS SIZE, WHICH IS 6,280,000,000,000,000,000 ELECTRONS. TODAY THE COULOMB HAS BEEN REPLACED BY THE AMPERE, WHICH IS BASICALLY THE SAME MEASUREMENT WITH THE DIFFERENCE BEING THE METHOD OF CALCULATION.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. UNITS OF ELECTRICAL MEASURE | NOTE: ESTABLISHED IN ORDER TO STUDY, DESCRIBE, AND TO PREDICT ELECTRICITY FOR USEFUL PURPOSES AND CONTROL |
| 1. VOLT | 1. IS THE UNIT OF ELECTRICAL FORCE<br>a. ELECTROMOTIVE FORCE MAY BE INDICATED BY LETTERS E.M.F.<br>b. MORE COMMON USE IS THE TERM VOLTAGE<br>2. IS DEFINED AS THAT PRESSURE WHICH WILL FORCE 1 AMPERE OF CURRENT THROUGH THE RESISTANCE OF 1 OHM |
| 2. COULOMB | 1. IS THE SIMPLEST ELECTRICAL UNIT, WHICH IS 6,280,000,000,000,000,000 ELECTRONS<br>2. NOT USED IN PRACTICAL APPLICATIONS - HAS BEEN REPLACED BY THE AMPERE |
| 3. AMPERE | 1. IS A MEASUREMENT OF THE RATE OF FLOW<br>2. IS THE NUMBER OF ELECTRONS PASSING A GIVEN POINT PER SECOND<br>EXAMPLE:<br>ONE AMPERE = ONE COULOMB/SECOND; TEN COULOMBS/SECONDS = TEN AMPERES |
| 4. OHM | 1. IS THE MEASUREMENT OF ELECTRICAL RESISTANCE<br>2. OHM IS DEFINED AS THE RESISTANCE OF A CONDUCTOR WHICH WILL PERMIT 1 AMP OF CURRENT TO FLOW THROUGH IT WHEN 1 VOLT OF PRESSURE IS APPLIED TO CONDUCTOR |
| 5. WATT | 1. IS A MEASUREMENT OF ELECTRICAL POWER<br>2. IS THE RATE OF WORK PER UNIT OF TIME<br>a. HORSE POWER = 33,000 FT. LBS. OF WORK PER MINUTE<br>b. WATT = 1/746 HORSEPOWER |

6. RESISTANCE

1. IS THE WILLINGNESS OR UNWILLINGNESS TO ALLOW THE FLOW OF ELECTRONS THROUGH A MATERIAL
2. DEPENDS ON THE KIND OF MATERIAL
   a. MATERIALS WHICH FREELY ALLOW THE FLOW OF ELECTRONS ARE CALLED CONDUCTORS

      EXAMPLE: SILVER, COPPER

   b. MATERIALS WHICH RESIST THE FLOW OF ELECTRONS ARE CALLED INSULATORS

      EXAMPLES: RUBBER, PLASTIC

TRANSPARENCY FIG. 186-187

3. IS AFFECTED BY THE LENGTH AND CROSS-SECTIONAL AREA OF THE CONDUCTOR
   a. IS DIRECTLY PROPORTIONAL TO THE LENGTH OF A WIRE
   b. IS INVERSELY PROPORTIONAL TO THE CROSS-SECTIONAL AREA OF A WIRE

   NOTE: A WIRE, ONE MIL (.001") IN DIAMETER AND ONE FOOT LONG IS THEN CALLED A MIL-FOOT

   EXAMPLE: A TWO MIL (.002") DIAMETER WIRE, ONE FOOT LONG WOULD CONTAIN FOUR MIL-FEET, SINCE ITS CROSS-SECTIONAL AREA IS FOUR TIMES THAT OF ONE MIL

4. ALSO DEPENDS ON THE TEMPERATURE OF THE CONDUCTING FIELD
   a. INTERNAL FRICTION IS CREATED BY THE MOVEMENT OF ELECTRONS CAUSING HEAT
   b. THE HIGHER THE TEMPERATURE, THE GREATER THE RESISTANCE
5. IS MEASURED IN OHMS

B. FORMULAS FOR ELECTRICAL MEASUREMENT

1. ALL THE UNITS OF MEASURE HAVE AN EFFECT ON ONE ANOTHER DEPENDING ON THE QUANTITIES IN WHICH THEY ARE MIXED

2. G.S. OHM, A GERMAN SCIENTIST, DETERMINED THAT THE CURRENT IN A WIRE IS PROPORTIONAL TO THE E.M.F., THEREFORE:
   a. WHEN THE E.M.F. APPLIED TO A DEVICE IS INCREASED, THE CURRENT INCREASES
   b. WHEN RESISTANCE IS INCREASED WITHOUT CHANGING THE E.M.F., THERE IS LESS CURRENT

1. OHM'S LAW

1. COMBINING THESE TRUTHS, OHM DEVELOPED THE FORMULA:

$$\text{CURRENT} = \frac{\text{EMF}}{\text{RESISTANCE}} \quad \text{OR:}$$

$$\text{AMPS} = \frac{\text{VOLTS}}{\text{OHMS}}$$

2. ALGEBRAICALLY EXPRESSED IS: $I = \frac{E}{R}$ WHEN:
   a. "I" REPRESENTS INTENSITY OF THE CURRENT (AMPS)
   b. "E" REPRESENTS ELECTROMOTIVE FORCE (VOLTS)
   c. "R" REPRESENTS THE RESISTANCE (OHMS)

TRANSPARENCY FIG. 188

3. WHEN TWO VALUES ARE KNOWN, THE THIRD VALUE MAY BE CALUCATED:
   a. AMPERAGE IS: $I = \frac{E}{R}$
   b. VOLTAGE IS: $E = I \times R$
   c. OHMS IS: $R = \frac{E}{I}$

2. WATTAGE FORMULA

1. DETERMINED BY MULTIPLYING VOLTAGE TIMES AMPERAGE: (PUT ON THE CHALKBOARD)
2. VOLTS X AMPERES = WATTS
   PRESSURE X CURRENT FLOW = POWER

C. CURRENTS

1. TWO TYPES
   a. DIRECT CURRENT
   b. ALTERNATING CURRENT
2. DIRECT CURRENT IS THE STEADY FLOW OF ELECTRONS IN ONE DIRECTION

   a. TYPE CURRENT PRODUCED FROM BATTERY
   b. DIFFICULT TO DELIVER OVER LONG DISTANCES

3. ALTERNATING CURRENT RESULTS FROM APPLYING VOLTAGE IN FIRST ONE DIRECTION AND THEN THE OPPOSITE
   a. THE MOVEMENT IN ONE DIRECTION; THEN A BRIEF STOP; THE MOVEMENT IN THE OPPOSITE DIRECTION; THEN A BRIEF STOP CONSTITUTES ONE (1) CYCLE
   b. THE NUMBER OF CYCLES PER SECOND DETERMINES THE TYPE OF SERVICE

      EXAMPLE: THE U.S. HAS A STANDARD 60 CYCLE AC CURRENT WHICH MEANS 60 CYCLES PER SECOND

SHOW: FILMSTRIP

4. SHOW FILMSTRIP: "ELECTRICAL DIAGRAMS" - PART I
   a. TELL STUDENTS WHAT TO LOOK FOR
   b. SHOW FILMSTRIP
   c. DISCUSS FILMSTRIP WITH CLASS

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION)

ASSIGNMENT SHEET VIII-C-2(A), PASS OUT FOR STUDENTS TO COMPLETE

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

TRUE - FALSE QUESTIONS

1. A CIRCULAR MIL IS .001" IN DIAMETER. T
2. A CLOSED CIRCUIT IS ONE COMPLETELY ENCLOSED BY INSULATION. F
3. THE PATH OF ELECTRICITY FOLLOWS THE PATH OF LEAST RESISTANCE. T
4. THE RATE OF FLOW OF CURRENT IS MEASURED IN VOLTS. F

| | | |
|---|---|---|
| 5. | ONE COULOMB PER SECOND IS ONE AMP. | T |
| 6. | OHM'S LAW STATES THAT WHEN THE E.M.F. OF A DEVICE IS INCREASED, THE CURRENT IN INCREASED. | T |
| 7. | OHM'S LAW CAN BE WRITTEN IN THE ABBREVIATED FORM $I = \frac{R}{E}$. | F |
| 8. | RESISTANCE IS USED TO CONTROL CURRENT FOR THE PRODUCTION OF HEAT. | T |
| 9. | COPPER IS A GOOD RESISTING ELEMENT. | F |
| 10. | RESISTANCE IS DIRECTLY PROPORTIONAL TO THE CROSS-SECTIONAL AREA OF THE CONDUCTOR. | F |
| 11. | THE WATT IS A MEASURE OF ELECTRIC POWER. | T |
| 12. | WATTS ARE FIGURED BY MULTIPLYING CURRENT FLOW BY ELECTRICAL PRESSURE. | T |
| 13. | TEMPERATURE DOES NOT AFFECT THE RESISTING QUALITIES OF A MATERIAL. | F |
| 14. | DIRECT CURRENT IS DIFFICULT TO DELIVER OVER LONG DISTANCES. | T |
| 15. | THE U.S. ALTERNATING CURRENT IS SET UP ON A 60 CYCLE SERVICE. | T |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS)

THE COULOMB IS THE MOST BASIC ELECTRICAL MEASUREMENT. IT MEASURES A QUANTITY OF ELECTRONS.

AMPERES MEASURES A RATE OF FLOW OF ELECTRONS. ONE AMPERE EQUALS ONE COULOMB/SECOND.

THE VOLT IS THE MEASURE OF ELECTRICAL PRESSURE - OFTEN CALLED E.M.F. (ELECTRON MOVING FORCE). IT IS THE AMOUNT OF FORCE REQUIRED TO MOVE ONE AMPERE OF CURRENT THROUGH ONE OHM OF RESISTANCE.

OHM IS A MEASURE OF ELECTRICAL RESISTANCE - THE UNWILLINGNESS OF MATERIALS TO THE PASSAGE OF ELECTRONS.

RESISTANCE IS MORE FOR:

a. LONG DISTANCES THAN SHORT DISTANCES
b. THIN CONDUCTORS THAN THICK CONDUCTORS
c. HOT WIRES THAN COLD WIRES
d. IRON THAN FOR COPPER

OHM'S LAW ABBREVIATED IS E = IR

E IS E.M.F. IN VOLTS
I IS CURRENT IN AMPERES
R IS RESISTANCE IN OHMS

THE WATT IS THE MEASUREMENT OF ELECTRIC POWER. POWER IS MEASURED AS THE RATE OF WORK PER UNIT OF TIME. THE POWER USED IN A CIRCUIT IS DETERMINED BY MEASURING THE AMOUNT OF VOLTAGE AND CURRENT AND MULTIPLYING THEM TOGETHER. POWER, OR WATTS, EQUALS VOLTS TIMES AMPERES.

CURRENTS ARE OF TWO TYPES:

a. DIRECT CURRENT (D.C.) IS CURRENT FROM ONE DIRECTION AS IN BATTERIES.
b. ALTERNATING CURRENT (A.C.) IS CURRENT WHICH ALTERNATES FIRST FROM ONE DIRECTION, THEN THE OPPOSITE (IN CYCLES) AS WITH GENERATORS.

SUGGESTED READING FOR STUDENT:

AUTOMECHANICS, CH. 2

THE NEXT LESSON IS: VIII-C-3(I) "ELECTRICAL CIRCUITS AND MEASURING DEVICES"

VIII-C-2(A)

# ASSIGNMENT SHEET
# ON
# THE AUTOMOTIVE ELECTRICAL SYSTEM

**SUBJECT:** Ohm's Law

**AIM:** The student will be able to calculate amperage, voltage, and resistance in a circuit through the use of Ohm's Law.

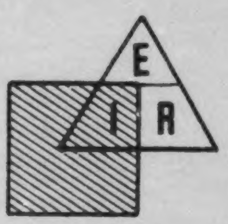
**INTRODUCTORY INFORMATION:** G.S. Ohm, a German scientist, discovered that an electrical current, its electromotive force, and its resistance all affect each other. He stated that one ohm of resistance is exactly that amount of resistance which allowed one volt of E.M.F. to push one ampere of current through it. When the E.M.F. is increased, the current is increased, but when resistance is increased without changing the E.M.F., the current is reduced. Combining these statements into a mathematical formula we have:

$$\text{amperes of current} = \frac{\text{E.M.F. in volts}}{\text{ohms resistance}}$$

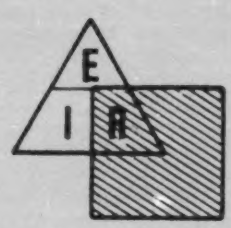
This is Ohm's Law. When two of these facts are known the third may be calculated.

Written in abbreviated form:
E stands for "EMF"
I stands for "intensity of current"
R stands for "resistance"

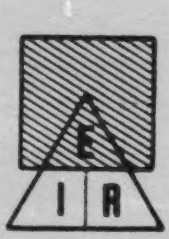
These formulas are easy to remember by putting them into a triangle and covering the one to be solved as shown below.



$I = \frac{E}{R}$



$R = \frac{E}{I}$



$E = IR$

**REFERENCES:** Automechanics, Glenn, Chpt. 2

**QUESTIONS AND/OR PROBLEMS:**

1. A portable generator develops an E.M.F. of 50 volts to feed a portable welder. The welder is rated at 40 amps. How many allowable ohms are permitted in the circuit which allows full efficiency of the welder?

**QUESTIONS AND/OR PROBLEMS:**

2. How many volts are required to cause a current of 2.5 amps in a 20 ohm lamp?

3. If a lamp of 4 ohm resistance is connected to a 12 volt battery, how much is the current?

4. Nine lights connected to the same circuit (parallel) requires 15 amps on a 12 volt battery. Allowing no resistance in the circuit, each lamp produces how much resistance?

5. An electric toaster uses 7.5 amps on a 115 volt line. What is the resistance of the toaster?

6. An air conditioner runs on a 220 volt line and is rated 14.5 amperes. What is its resistance?

7. An electric motor is run on a 220 volt line. Its known resistance is 18 ohms. How many amps are required to run the motor at its rated capacity?

8. How many volts are required to operate a 5 HP motor rated at 7.5 amps with a measured resistance of 16 ohms?

9. An electric heater's measured resistance is 12 ohms and operates on 120 volt. What is its amperage rating?

10. A 120 volt parallel circuit carries two appliances. The line current from source is 10 amps and the first appliance has a known resistance of 20 ohms. What is the resistance in ohms of the second appliance?

VIII-C-2(A)

## ASSIGNMENT SHEET
## KEY

1. $R = \frac{E}{I} = \frac{50}{40} = 1.25$ ohms

2. $E = IR = 2.5 \times 10 = 25$ volts

3. $I = \frac{E}{R} = \frac{12}{4} = 3$ amps

4. $R = \frac{E}{I} = \frac{15}{12} = 1.25$ amps

5. $R = \frac{E}{I} = \frac{115}{7.5} = 15.33$ ohms

6. $R = \frac{E}{I} = \frac{220}{14.5} = 29.33$ ohms

7. $I = \frac{E}{R} = \frac{220}{18} = 12.22$ amps

8. $E = IR = 7.5 \times 16 = 120$ volts

9. $I = \frac{E}{R} = \frac{120}{12} = 10$ amps

10. $I = \frac{120}{20} = 6$ amps (1st appliance)

    $R = \frac{120}{4} = 30$ ohms (2nd appliance)

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-3(I)

| | |
|---|---|
| SUBJECT: | ELECTRICAL CIRCUITS & MEASURING DEVICES |
| AIM: | THE STUDENT WILL BE ABLE TO EXPLAIN THE THREE BASIC TYPES OF ELECTRICAL CIRCUITS AND VERIFY THE DISTRIBUTION OF CURRENT, RESISTANCE, AND VOLTAGE IN EACH |
| TEACHING AIDS: | TRANSPARENCY I. ED. II-7T FIG. 189; CHALKBOARD<br>FILMSTRIP: #3000-207-FSR1, "USING THE WIRING DIAGRAMS"<br>FILMSTRIP: #3000-203-72S7, "ELECTRICAL DIAGNOSIS PART III," FORD MOTOR CO., MARKETING DIVISION |
| MATERIALS: | CHALK |
| REFERENCES: | INTRODUCTION TO ELECTRICITY AND ELECTRONICS; LOPER AND AHR; CHPTS. 3, 7<br>FUNDAMENTALS OF ELECTRICITY; GRAHAM; CHS. 4, 12 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT TO HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSON III-A-2(I), ELECTRIC CURRENTS AND MEASUREMENTS |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

AN ELECTRIC CIRCUIT IS ANY ARRANGEMENT OF MATERIALS WHICH PERMITS THE FLOW OF ELECTRONS. THERE ARE THREE BASIC ARRANGEMENTS, OR TYPES, OF CIRCUITS IN ELECTRICITY. CERTAIN BASIC RULES IN THE OPERATION OF THESE CIRCUITS ARE IMPORTANT IN DEVELOPING A SKILL FOR LOCATING FAULTS IN ELECTRICAL EQUIPMENT.

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### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. ELECTRIC CIRCUIT | 1. IS ANY ARRANGEMENT OF MATERIALS WHICH PERMITS THE FLOW OF ELECTRONS |
| TRANSPARENCY FIG. 189 | 2. IMPLIES A COMPLETE CONDUCTING PATH LEADING FROM THE SOURCE OF ENERGY TO THE POINT OF USE AND BACK TO THE SOURCE AGAIN<br>a. OPEN CIRCUIT - IMPLIES ONE THAT DOES NOT COMPLETE THE CIRCUIT |

LOOP-AN OPEN SWITCH OR BURNED OUT FILAMENT

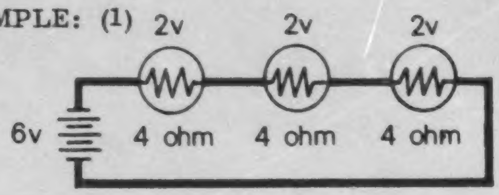
   b. CLOSED CIRCUIT - DOES COMPLETE THE LOOP ALLOWING THE FLOW OF CURRENT
   c. SHORT CIRCUIT-A PARALLEL PATH OF LOWER RESISTANCE OFTEN CAUSED ACCIDENTALLY

3. ELECTRICITY FOLLOWS THE PATH OF LEAST RESISTANCE
4. THE THREE BASIC CIRCUITS IN ELECTRICITY ARE: SERIES, PARALLEL, AND SERIES - PARALLEL

1. SERIES CIRCUIT

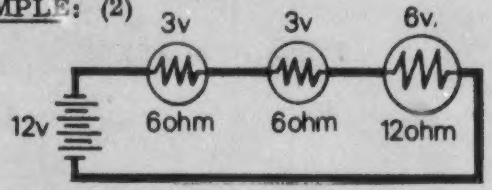
1. IS WHEN THERE IS ONLY ONE POSSIBLE ROUTE THROUGH SEVERAL DEVICES AND BACK TO THE SOURCE
2. SINCE ONLY ONE PATH FOR CURRENT EXISTS, THE CURRENT THROUGH ALL DEVICES IS THE SAME
3. VOLTAGE APPLIED TO A SERIES CIRCUIT IS DISTRIBUTED ACROSS THE VARIOUS RESISTANCES IN A SERIES OF "VOLTAGE DROPS"
   a. VOLTAGE ACROSS EACH RESISTOR OF EQUAL RESISTORS IN SERIES ARE EQUAL PARTS OF THE TOTAL VOLTAGE
   b. VOLTAGE ACROSS EACH RESISTOR OF UNEQUAL RESISTORS IN SERIES IS IN PROPORTION TO THE RESISTANCE
4. THE SUM OF THE VOLTAGE DROP ACROSS THE INDIVIDUAL RESISTORS IN SERIES CIRCUIT IS EQUAL TO THE TOTAL APPLIED VOLTAGE
5. THE TOTAL RESISTANCES OF A SERIES CIRCUIT IS EQUAL TO THE SUM OF ALL RESISTANCE IN THE CIRCUIT

EXAMPLE: (1)



ohm's law: $1 = \frac{E}{R} = \frac{6}{12} = .5$ amps

**EXAMPLE**: (2)



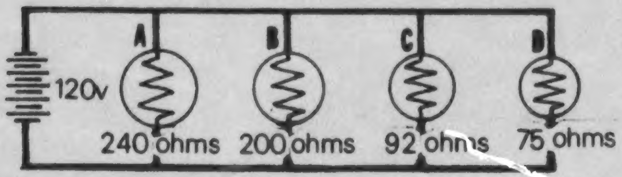
ohm's law: $1 = \frac{E}{R} = \frac{12}{24} = .5$ amps

**NOTE**: PLACE EXAMPLES ON CHALKBOARD AND DISCUSS WITH CLASS

6. IS EITHER AN "ALL OR NONE" CIRCUIT, EITHER EVERYTHING OR NOTHING WILL WORK

2. PARALLEL CIRCUIT

1. IS ARRANGED IN SUCH A WAY THAT EACH RESISTANCE IS SUPPLIED WITH A SEPARATE PATH FOR CURRENT FLOW
2. ALL DEVICES (RESISTANCES) OPERATE ON THE SAME LINE VOLTAGE SINCE EACH DEVICE HAS ITS OWN PATH FOR CURRENT



ohm's law: $1 = \frac{E}{R}$

FOR "A": $\frac{120}{240} = .5$ AMPS

FOR "B": $\frac{120}{200} = .6$ AMPS

FOR "C": $\frac{120}{92} = 1.3$ AMPS

FOR "D": $\frac{120}{75} = 1.6$ AMPS

3. TOTAL CURRENT IS EQUAL TO THE SUM OF THE INDIVIDUAL CURRENTS

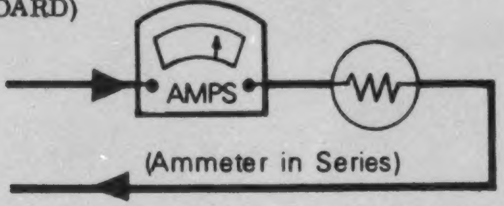
**EXAMPLE**: (SEE ABOVE ILLUSTRATION)

| | |
|---|---|
| | TOTAL CURRENT = 1.6+.6+1.3+.5=4 AMPS |
| 3. SERIES - PARALLEL | 1. OFTEN NECESSARY TO MEET DESIRED ELECTRICAL CONDITIONS<br>2. THE SAME LAWS WHICH DETERMINE CURRENT, VOLTAGE, AND RESISTANCE FOR SERIES AND PARALLEL APPLY TO THIS COMBINATION DEPENDENT ON ITS ARRANGEMENT<br>3. SHOW FILMSTRIP - "USING WIRING DIAGRAMS"<br>a. TELL STUDENTS WHAT TO LOOK FOR<br>b. SHOW FILMSTRIP<br>c. DISCUSS FILMSTRIP WITH CLASS |
| B. MEASURING INSTRUMENTS | 1. THE THREE MOST COMMONLY USED INSTRUMENTS FOR ELECTRICAL MEASUREMENTS ARE AMMETERS, VOLTMETERS, AND OHMMETERS<br>2. EACH MEASURES WHAT ITS NAME IMPLIES<br>3. ALL ARE SIMILAR IN CONSTRUCTION BEING MODIFICATIONS OF A BASIC INSTRUMENT, THE GALVANOMETER |
| 1. GALVANOMETER | 1. IS THE BASIC INSTRUMENT IN THE DESIGN OF THE OTHER MEASUREMENT INSTRUMENTS<br>2. CONSISTS OF A PERMANENT MAGNET WITH STATIONARY CYLINDRICAL CORE BETWEEN THE POLES TO CREATE A UNIFORMLY STRONG MAGNETIC FIELD WITHIN A MOVABLE COIL<br>3. THE MOVABLE COIL IS SUPPORTED ON A JEWELED PIVOT SIMILAR TO THE MAIN SPRING OF A WATCH AND IS ATTACHED TO THE DIAL INDICATOR NEEDLE<br>4. WHEN A CURRENT IS INTRODUCED THE COILS TURN SO THAT UNLIKE POLES MOVE CLOSER TOGETHER. THIS MOVES THE INDICATOR NEEDLE |
| 2. AMMETER | 1. MEASURES CURRENT<br>2. IS DESIGNED FOR RESISTANCE LOW ENOUGH SO AS NOT TO INTERFERE |

WITH CURRENT BEING MEASURED

3. USED TO CHECK CURRENT THROUGH A PIECE OF EQUIPMENT
   a. CURRENT PASSING THROUGH THE EQUIPMENT MUST PASS THROUGH THE METER
   b. THE METER MUST BE IN SERIES WITH EQUIPMENT BEING TESTED

**EXAMPLE:** (ILLUSTRATE ON CHALKBOARD)



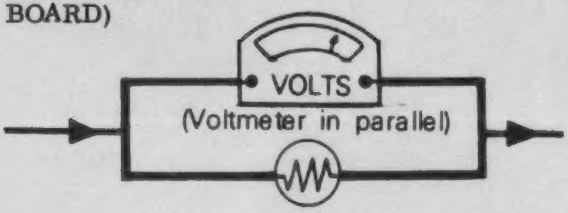
(Ammeter in Series)

4. FAILURE TO CONNECT AN AMMETER PROPERLY MAY BURN OUT THE METER OR ACT AS A "SHORT CIRCUIT"
5. DISPLAY TYPICAL AMMETER STUDENTS WILL USE, AND DISCUSS WITH CLASS

3. VOLTMETER

1. MEASURES VOLTAGE (E.M.F.)
2. IS DESIGNED AS A HIGH RESISTANCE INSTRUMENT TO:
   a. ALLOW ONLY A VERY SMALL CURRENT THROUGH THE VOLTMETER
   b. DOES NOT CAUSE DRAIN ON ELECTRICAL PRESSURE BEING MEASURED
3. TO MEASURE E.M.F. OF A PIECE OF EQUIPMENT, CONNECT VOLTMETER IN PARALLEL

**EXAMPLE:** (ILLUSTRATE ON CHALKBOARD)



(Voltmeter in parallel)

4. THE VOLTMETER CAN BE CONNECTED ACROSS SOURCE OF ENERGY TO CHECK TOTAL VOLTAGE IN A CIRCUIT

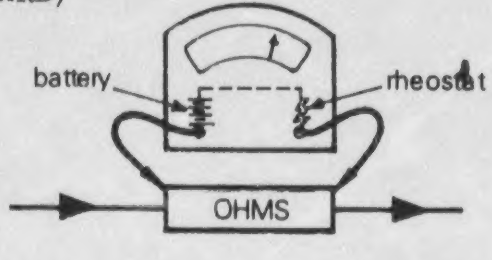
5. DISPLAY TYPICAL VOLTMETER STUDENTS WILL USE AND DISCUSS WITH CLASS

NOTE: THE + TERMINAL OF THE VOLTMETER IS CONNECTED TO THE + SIDE OF THE SUPPLY SOURCE

4. OHMMETER

1. MEASURES RESISTANCE
2. DIFFERS FROM OTHER INSTRUMENTS IN THAT IT CONTAINS ITS OWN SOURCE OF ENERGY (BATTERY OPERATED)
3. INSTRUMENT IS CALLED TO MEASURE RESISTANCE BETWEEN ITS LEADS
4. CHECK INSTRUMENTS BEFORE USE
    a. TOUCH TIPS OF LEADS TOGETHER CAUSING SHORT CIRCUIT
    b. WHILE LEADS ARE CONNECTED ADJUST RHEOSTAT SO THAT THE POINTER OF THE METER IS OVER THE "O" OHMS MARK
5. TO CHECK RESISTANCE IN A CIRCUIT
    a. TURN OFF POWER SUPPLY
    b. DISCHARGE ANY ELECTROLYTIC CAPACITORS
    c. CONNECT OHMMETER BY TOUCHING LEADS TO EACH END OF RESISTANCE (EQUIPMENT) TO BE CHECKED
    d. READ RESISTANCE IN OHMS ON METER

EXAMPLE: (ILLUSTRATE ON CHALKBOARD)



6. DISPLAY TYPICAL OHMMETER STUDENTS WILL USE AND DISCUSS

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

FILMSTRIP: "ELECTRICAL DIAGNOSIS - PART III"
TELL STUDENTS WHAT TO LOOK FOR.
SHOW FILMSTRIP.
DISCUSS FILMSTRIP WITH CLASS.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL:

| | | |
|---|---|---|
| 1. | THE THREE TYPES OF ELECTRICAL CIRCUITS ARE SERIES, PARALLEL, AND _____. | SERIES-PARALLEL |
| 2. | IT IS MOST REASONABLE TO CONNECT THE HEADLIGHTS OF AN AUTOMOBILE IN _____. | PARALLEL |
| 3. | A PARALLEL PATH OF LOWER RESISTANCES DEFINES A/AN _____. | SHORT CIRCUIT |
| 4. | ANY ARRANGEMENT OF MATERIALS WHICH PERMITS THE FLOW OF ELECTRONS IS A/AN _____. | ELECTRIC CURRENT |
| 5. | A CIRCUIT IN WHICH THERE IS ONLY ONE PATH FOR CURRENT TO FLOW IS CALLED A/AN _____. | SERIES |
| 6. | THE TOTAL E. M. F. IN A CIRCUIT CAN BE CHECKED WITH A/AN _____. | VOLTMETER |
| 7. | ELECTRICITY FOLLOWS THE PATH OF LEAST _____. | RESISTANCE |
| 8. | THE INSTRUMENT USED TO CHECK CURRENT INTENSITY IS THE _____. | AMMETER |
| 9. | THE OHMMETER DIFFERS FROM OTHER ELECTRICAL MEASURING INSTRUMENTS IN THAT IT CONTAINS ITS OWN _____. | SOURCE OF ENERGY |
| 10. | THE _____ MUST BE ADJUSTED ON THE OHMMETER UNTIL THE NEEDLE READS ZERO OHMS BEFORE USING. | RHEOSTAT |
| 11. | FOR VOLTMETERS AND AMMETERS TO READ CORRECTLY, THE PLUS (+) TERMINAL OF THE METER MUST CONNECT WITH THE _____ OF THE POWER SOURCE. | PLUS SIDE |
| 12. | OHMMETERS, AMMETERS, AND VOLTMETERS ARE ALL MODIFICATIONS OF A BASIC INSTRUMENT CALLED _____. | GALVANOMETER |

## IV. VERIFICATION (CON'T.)

13. THE PURPOSE OF THE AMMETER IS TO FIND HOW MUCH _____ IS IN A PIECE OF EQUIPMENT. CURRENT

14. A SINGLE LIGHT OPERATES ON A 6 VOLT BATTERY, AND IS KNOWN TO HAVE 3 OHMS RESISTANCE. ITS AMPERAGE RATING IS _____. 2 AMPS

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE THREE MAJOR TYPES OF ELECTRICALS CIRCUITS ARE SERIES, PARALLEL AND SERIES - PARALLEL.

### SERIES CIRCUIT

THERE IS ONLY ONE PATH FOR CURRENT IN A SERIES CIRCUIT. EACH ITEM IN SERIES HAS THE SAME CURRENT AS THE OTHER DEVICES. CURRENT DEPENDS ON APPLIED VOLTAGE AND TOTAL RESISTANCE. TOTAL VOLTAGE IS EQUAL TO THE SUM OF THE INDIVIDUAL VOLTAGES. TOTAL RESISTANCE IS EQUAL TO THE SUM OF THE INDIVIDUAL RESISTANCES.

### PARALLEL CIRCUIT

CURRENT PATH IS DIVIDED SO THAT EACH DEVICE IN PARALLEL HAS ITS OWN SOURCE OF POWER. TOTAL CURRENT IS DIVIDED ALSO SO THAT INDIVIDUAL CURRENTS ARE IN DIRECT PROPORTION TO THE INDIVIDUAL RESISTANCE. THE VOLTAGE REMAINS CONSTANT FOR ITEMS IN PARALLEL. A SHORT CIRCUIT IS A PARALLEL PATH OF TOO-LOW RESISTANCE.

### SERIES-PARALLEL

THE SAME LAWS APPLY TO SERIES-PARALLEL CIRCUITS AS FOR A SERIES OR A PARALLEL CIRCUIT. THEY MUST BE TAKEN IN ORDER FROM THE SOURCE OF ENERGY AND DEALT WITH INDIVIDUALLY.

THREE TYPES OF ELECTRICAL MEASURING INSTRUMENTS ARE AMMETER, VOLTMETER, AND OHMMETER. ALL UTILIZE THE PRINCIPLE OF THE GALVANOMETER WITH MODIFICATIONS.

### AMMETER

MEASURES AMPERAGE OR CURRENT OF A PIECE OF EQUIPMENT. A LOW RESISTANCE METER IS DESIGNED SO AS NOT TO INTERFERE WITH CURRENT BEING MEASURED. MUST BE CONNECTED IN SERIES WITH DEVICE BEING MEASURED.

VOLTMETER

MEASURES THE ELECTROMOTIVE FORCE IN VOLTS. A HIGH-RESISTANCE METER DESIGN TO ALLOW A VERY SMALL CURRENT TO OPERATE IT. MAY BE CONNECTED DIRECTLY TO POWER SOURCE OR IN PARALLEL WITH DEVICE TO BE MEASURED.

OHMMETER

MEASURES RESISTANCE OF A DEVICE. USED ONLY ON A DEAD CIRCUIT ITEM. CONTAINS OWN POWER SOURCE (BATTERY). RHEOSTAT TO BE ADJUSTED FOR "O" READING BEFORE USE.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 7

THE NEXT LESSON IS: VIII-C-4(I), "STORAGE BATTERIES"

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-4(I)

| | |
|---|---|
| SUBJECT: | STORAGE BATTERIES |
| AIM: | THE STUDENT WILL BE ABLE TO EXPLAIN THE OPERATION OF STORAGE BATTERIES; KNOW THE VARIOUS PARTS AND THEIR FUNCTIONS IN ORDER TO ASSIST IN THE DIAGNOSIS AND CARE OF AUTOMOTIVE STORAGE BATTERIES. |
| TEACHING AIDS: | EXAMPLES OF VARIOUS TYPES OF STORAGE BATTERIES<br>TRANSPARENCIES I. ED. II-7T, FIGS. 190-195, CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | INTRODUCTION TO ELECTRICITY AND ELECTRONICS, LOPER AND AHR; CH. 11<br>AUTOMOTIVE ELECTRICAL EQUIPMENT, CROUSE; CHS. 2,3 |
| PREREQUISITE EXPERIENCE OF THE LEARNERS: | THE STUDENT MUST HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSON VIII-C-3(I) "ELECTRICAL CIRCUITS AND MEASURING DEVICES" |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE STORAGE BATTERY IS SAID TO BE THE HEART OF THE AUTOMOBILE. CERTAINLY, IT IS THE HEART OF THE AUTOMOBILE'S ELECTRICAL SYSTEM. IT IS USED PRIMARILY TO PROVIDE CURRENT FOR STARTING THE ENGINE. IT ALSO PROVIDES CURRENT FOR THE COMPLETE ELECTRICAL SYSTEM OF THE AUTOMOBILE WHEN THE ENGINE IS NOT OPERATING TO GENERATE POWER. BATTERY ENERGY IS EXPENSIVE ENERGY. AT BEST A FLASHLIGHT BATTERY MAY PRODUCE 5 WATTHOURS OF ENERGY. IF THE CELL COST 15 CENTS THE BUYER WOULD BE PAYING $30.00 PER KWH OF ENERGY. COMPARE THIS TO 2 CENTS PER KWH FOR LINE POWER ENERGY. THE STUDENTS OF THE AUTOMOTIVE INDUSTRY NEED TO UNDERSTAND HOW THE BATTERY FUNCTIONS SO THAT THEY MAY BETTER CARE FOR, AND PRACTICE PREVENTATIVE MAINTENANCE ON, CAR BATTERIES. THE ABILITY TO INSTALL, TEST, CHARGE, AND MAINTAIN STORAGE BATTERIES WILL BE AN IMPORTANT ASSET TO AN APPRENTICE OF THE AUTOMOTIVE TRADE.

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### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. BASIC PRINCIPLES | 1. PRIMARILY USED WHERE POWER LINE SERVICE IS IMPRACTICAL<br>2. BATTERY DOES NOT STORE ELECTRI- |

CITY AT ALL

3. BATTERY CONSISTS OF AN ELECTROCHEMICAL CELL OR GROUP OF CELLS WHICH CONVERT CHEMICAL ENERGY TO ELECTRICAL ENERGY
4. WHEN THE CIRCUIT IS CLOSED, THE ACTIVE MATERIALS WITHIN THE CELLS REACT CHEMICALLY TO CAUSE A FLOW OF ELECTRONS (CURRENT) TO OPERATE CURRENT CONSUMING DEVICES WITHIN THE CIRCUIT

| | |
|---|---|
| 1. THE ELECTRIC CELL | 1. COMPOSED OF AN ELECTRON RICH MATERIAL (GERERALLY A METAL OR METALLIC OXIDE) WHOSE ENERGETIC ELECTRONS ARE EASILY TRANSFERABLE TO SOME KIND OF AN ELECTRON GRABBING MATERIAL (A + CHARGED ION) |
| TRANSPARENCY FIG. 190 | 2. THIS TRANSFER IS MADE THROUGH TERMINALS AND A CLOSED CIRCUIT<br>a. THE TERMINAL WHERE ELECTRONS LEAVE THE CELL IS CALLED THE ANODE AND IS THE (-) TERMINAL, FOR IT IS ELECTRON RICH<br>b. THE TERMINAL WHERE ELECTRONS ENTER THE CELL IS CALLED THE CATHODE (+) TERMINAL WHICH ATTRACTS THE ELECTRONS<br>3. ELECTRONS (CURRENT) FLOWS FROM NEGATIVE (-) TO POSITIVE (+) |
| 2. BATTERY TYPES | 1. BATTERY TYPES ARE BASED ON THE TYPE OF MATERIAL USED IN THE BODY OF THE CELL<br>2. THE TWO MAJOR TYPES OF THE BATTERIES IN GENERAL USE TODAY ARE THE:<br>a. PRIMARY CELL BATTERY - OFTEN CALLED THE DRY CELL BATTERY<br>b. SECONDARY CELL BATTERY - OFTEN CALLED THE WET CELL BATTERY<br>3. PRIMARY CELLS - ARE THOSE IN WHICH THE ELECTRON TRANSFER IS NOT REVERSIBLE (NOT RECHARGABLE). IN |

THIS TYPE BATTERY, THE ELECTROCHEMICAL MATERIAL IS "BURNED UP" OR CONSUMED; BEING CONVERTED TO SOME LOW ENERGY FORM

EXAMPLE: FLASHLIGHT BATTERIES

4. SECONDARY CELLS - ARE THOSE CELLS THAT CAN BE CHARGED AGAIN
   a. THIS RECHARGING IS ACHIEVED BY FORCING OUTSIDE CURRENT (D.C.) THROUGH THE BATTERY IN THE OPPOSITE DIRECTION OF CURRENT FLOW DURING NORMAL DISCHARGE
   b. THIS REVERSES THE CHEMICAL ACTION AND RESTORES THE CHEMICAL PROPERTIES OF THE BATTERY

EXAMPLE: CAR BATTERIES

5. THE BATTERY MOST COMMONLY USED IN AUTOMOBILES IS THE LEAD-ACID TYPE MATERIAL

NOTE: SINCE WE ARE MOST INTERESTED IN AUTOMOBILE STORAGE BATTERIES, ALL FUTURE DISCUSSION WILL PERTAIN STRICTLY TO THAT TYPE BATTERY

3. BATTERY SIZE AND RATING

1. BATTERIES ARE MADE IN MANY PHYSICAL SIZES AND SHAPES TO MEET THE NEEDS OF THE VARIOUS VEHICLES
2. THE PHYSICAL SIZE IS INDICATED BY CODE NUMBERS AND LETTERS ESTABLISHED BY THE NATIONAL ASSOCIATION OF ENGINEERS AND MANUFACTURERS
3. BATTERIES ARE RATED BY VOLTAGE AND AMPERE-HOUR CAPACITY

TRANSPARENCY FIG. 191

4. EACH BATTERY CELL PRODUCES 2 VOLTS. THE CELLS ARE CONNECTED IN SERIES, AND THE TOTAL VOLTAGE IS 2 TIMES THE NUMBER OF CELLS

EXAMPLE; 12 VOLT BATTERY CONTAINS 6 CELLS WITH 2 VOLTS EACH

5. AMPERE - HOUR RATING IS A 20 HOUR

TEST TO DETERMINE HOW MUCH CURRENT IS FURNISHED BEFORE THE CELL VOLTAGE DROPS BELOW 1.75 VOLTS AT A SET TEMPERATURE OF 80° F.

EXAMPLE: A BATTERY DELIVERS 3 AMPS FOR 20 HOURS; 3 X 20 = 60 AMPERE-HOUR BATTERY

6. A LARGER CELL IS CAPABLE OF A HIGHER CURRENT THAN A SMALLER ONE. SIZE, HOWEVER, DOES NOT AFFECT THE STORAGE

B. BATTERY CONSTRUCTION

1. ALL STORAGE BATTERIES ARE SIMILAR IN CONSTRUCTION
2. THE MAIN DIFFERENCES IN BATTERIES ARE SIZE, NUMBER, AND ARRANGEMENT OF THEIR CELLS

1. CELLS

1. THE BASIC UNIT OF THE BATTERY IS THE CELL
2. THE CELL CONSISTS OF PLATES OF TWO DIFFERENT MATERIALS, WHICH ARE RATED HIGH IN CHEMICAL ENERGY, IMMERSED IN AN ELECTROYLTIC SOLUTION
3. THE SOLUTION REACTS WITH THE PLATES CHEMICALLY TO PRODUCE ELECTRICAL PRESSURE (VOLTAGE) BETWEEN THE PLATES
4. VOLTAGE DEPENDS ON THE TYPE OF MATERIAL OF THE PLATES AND THE ELECTROLYTE
5. EACH CELL INCLUDES:
    a. AN ELEMENT OF INTERLEAVED POSITIVE AND NEGATIVE PLATES
    b. SEPARATORS TO KEEP THE PLATES APART
    c. A CHAMBER TO HOLD THE ELEMENT - EACH CHAMBER HAS A FILLER CAP WITH AN AIR VENT
    d. AN ELECTROLYTE

2. PLATES

1. THE PLATES FABRICATED FOR A GRIDDED FRAMEWORK OF CAST LEAD AND

FILLED WITH THE ACTIVE MATERIALS MADE INTO A PASTE FORM
   a. POSITIVE PLATE GRIDS ARE FILLED WITH LEAD PEROXIDE PASTE WHICH TURNS BROWN WHEN IT HARDENS
   b. NEGATIVE PLATE GRIDS ARE FILLED WITH A SPONGE LEAD, GREYISH IN COLOR

2. THE PLATES ARE WELDED TOGETHER AT THEIR LUG ENDS INTO GROUPS
   a. THE NEGATIVE GROUP ALWAYS CONTAINS ONE PLATE MORE THAN THE POSITIVE GROUP
   b. THE GROUPS ARE INTERLEAVED AND SEPARATOR PLACED BETWEEN THEM

3. SEPARATORS

1. INSULATE THE PLATES ELECTRICALLY
2. ARE MADE OF A POROUS MATERIAL TO ALLOW CIRCULATION OF THE ELECTROLYTE
3. ARE GROOVED VERTICALLY TO ALLOW LOOSE ACTIVE MATERIAL TO FALL TO THE SEDIMENT BASIN

4. ELEMENT

1. IS FORMED BY ALTERNATING POSITIVE (+) AND NEGATIVE (-) PLATES IN A GROUP
2. EACH GROUP IS HELD TOGETHER BY A CONNECTION ON ONE SIDE WHICH ALSO SERVES FOR CONNECTING TO ELEMENTS OF OTHER CELLS IN MAKING UP THE BATTERY
3. SEPARATORS ARE INSERTED BETWEEN INDIVIDUAL PLATES TO INSULATE THE PLATES FROM EACH OTHER

5. ELECTROLYTE

1. AN ELECTROLYTE IS A NON-METALLIC CONDUCTOR OF ELECTRICITY IN WHICH THE CURRENT IS CARRIED, THROUGH THE MOVEMENT OF IONS
2. THE ELECTROLYTE USED TO COVER THE PLATES IN STORAGE BATTERIES IS A SOLUTION OF 38% SULPHURIC ACID AND 62% DISTILLED WATER

3. THE SULPHURIC ACID REACTS CHEMICALLY WITH THE MATERIALS ON THE PLATES TO PRODUCE ELECTRICITY BY FORMING A NEW COMPOUND AND RELEASING ELECTRONS
4. THIS ACTION IS REVERSED WHEN THE BATTERY IS RECHARGED

6. BATTERY CASE

1. USUALLY A ONE-PIECE MOLDED CONSTRUCTION OF PLASTIC OR HARD RUBBER TO WITHSTAND ACID ATTACK
2. CELL CHAMBERS ARE BUILT INTO THE ONE-PIECE MOLDED CASE
3. CASE CONTAINS SEDIMENT CHAMBER AT BOTTOM TO COLLECT MATERIALS SLOWLY WORN AWAY FROM THE PLATE
4. COVERED WITH A MOLDED CAP WHICH FITS OVER COMPLETE CASE AND CEMENTED AROUND THE OUTSIDE AND THE CELL PARTITIONS
5. THE CELL CONNECTORS AND TERMINALS ARE BUILT INTO THE MOLD, ALONG WITH FILLER CAP OPENINGS FOR EACH HOLD

C. BATTERY TESTING

1. A BATTERY KNOWN TO BE IN GOOD CONDITION SHOULD BE CHECKED PERIODICALLY TO INSURE THAT IT STAYS IN GOOD CONDITION
2. A GREAT MANY BATTERIES GO BAD DUE TO NEGLECT AND IMPROPER ATTENTION

1. HYDROMETER TEST

1. THE HYDROMETER MEASURES SPECIFIC GRAVITY
2. SPECIFIC GRAVITY IS BASED ON THE WEIGHT OF WATER AS THE UNIT 1
3. SPECIFIC GRAVITY IS A RATIO OF THE WEIGHT OF A VOLUME OF MATERIAL TO THE WEIGHT OF THE SAME VOLUME OF WATER

EXAMPLE:

A PINT OF WATER WEIGHS 1 lb.

A PINT OF SULPHURIC ACID WEIGHS 1.8 lbs.

$$\text{SPECIFIC GRAVITY} = \frac{\text{wt. of vol. of mat'l}}{\text{wt. of same vol. of water}}$$

$$\text{SPECIFIC GRAVITY} = \frac{1.8}{1} = 1.8 \text{ lbs.}$$

4. A HYDROMETER CONSISTS OF A GLASS TUBE WITH A RUBBER BULB SUCTION AT ONE END. INSIDE THE TUBE IS A WEIGHTED FLOAT WITH STEM MARKED SO THAT GRAVITY CAN BE READ
5. WHEN FLUID IS DRAWN INTO THE TUBE THE FLOAT RISES OR SINKS ACCORDING TO THE LIGHTNESS OF HEAVINESS OF THE FLUID
6. THE READING ON THE FLOAT STEM IS TAKEN AT EYE LEVEL WITH THE FLUID

EXAMPLE:

| MATERIAL | SPEC. GRAVITY |
|---|---|
| WATER | 1.0 |
| 15% ACID - 85% WATER (discharged battery ) | 1.1 |
| 39% ACID - 61% WATER (charged battery) | 1.270 |
| CONCENTRATED SULPHURIC ACID | 1.835 |

7. A FULLY CHARGED BATTERY SHOULD READ 1.270 ON THE HYDROMETER - BELOW IS A CHART ON SPECIFIC GRAVITY AND STATE OF CHARGE

| SPECIFIC GRAVITY | STATE OF CHARGE |
|---|---|
| 1.26 - 1.29 | FULLY CHARGED |
| 1.23 - 1.26 | ABOUT 3/4 CHARGED |
| 1.20 - 1.23 | ABOUT 1/2 CHARGED |
| 1.17 - 1.20 | ABOUT 1/4 CHARGED |
| 1.14 - 1.17 | ABOUT RUN DOWN |
| 1.11 - 1.14 | DISCHARGED |

NOTE: SOME BATTERIES ARE DESIGNED FOR TOP GRAVITY OF 1.27. IN EXTREME HOT CLIMATES SOME MAY BE ADJUSTED FOR TOP GRAVITY AS LOW AS 1.225

8. TEMPERATURE AFFECTS THE SPECIFIC GRAVITY
    - a. A HEATED SUBSTANCE EXPANDS
    - b. EXPANSION CAUSES IT TO BECOME THINNER-LOSES WEIGHT PER VOLUME AREA
    - c. LOSS OF WEIGHT - LOSS OF BUOYANCY OR GRAVITY

TRANSPARENCY
FIG. 192-193

9. TEMPERATURE AFFECTS THE SPECIFIC GRAVITY OF ELECTROLYTE IN BAT-

TERIES ABOUT .004 FOR EACH 10° VARIATION IN TEMPERATURE

EXAMPLE: BASED ON SPECIFIC GRAVITY READING AT 80° F.

1.250 @ 130°F; add 5 × .004 or .020
1.27 is corrected reading

1.250 @ 10°F; subtract 7 × .004 or .028
1.222 is corrected reading

10. HYDROMETER READING SHOULD NOT VARY BETWEEN CELLS MORE THAN .050. A GREATER VARIATION INDICATES DEFECTIVE BATTERY. DOUBLE CHECK ALL READINGS

NOTE: SULPHURIC ACID IN ELECTROLYTE IS VERY CAUSTIC AND WILL ATTACK MOST SUBSTANCES IT CONTACTS. HANDLE WITH GREAT CAUTION

2. HIGH-DISCHARGE TEST

1. MADE BY PLACING A HEAVY LOAD ON THE BATTERY AND MEASURING CELL VOLTAGES WHILE BATTERY IS UNDER THIS LOAD
2. THERE ARE SEVERAL INSTRUMENTS AND METHODS FOR DOING THIS. FOLLOW INSTRUMENT INSTRUCTION AND BATTERY MANUFACTURER'S RECOMMENDATIONS
3. REGARDLESS OF THE METHOD USED, THE BATTERY SHOULD
    a. BE AT LEAST HALF CHARGED
    b. HAVE CORRECT LEVEL OF ELECTROLYTE IN ALL CELLS
    c. HAVE NO OBVIOUS DEFECTS
    d. BE TESTED AT TEMPERATURES BETWEEN 60 AND 100° F.

D. BATTERY CARE

1. CHECK, FREQUENTLY, THE LEVEL OF THE ELECTROLYTE AND ADD WATER WHEN NECESSARY
    a. USE ONLY DISTILLED WATER
    b. COVER BATTERY PLATES APPROXIMATELY 3/8"
    c. AVOID OVERFILLING CELL

    d. TAKE CARE NOT TO GET DIRT IN THE CELLS
2. CHECK ELECTROLYTE WITH HYDROMETER SEASONALLY (ABOUT 4 TIMES A YEAR) OR BEFORE RE-CHARGING
3. A QUICK VISUAL INSPECTION EACH TIME THE HOOD IS RAISED (AT LEAST ONCE A WEEK) MAY DISCLOSE:
    a. MECHANICAL DAMAGE TO THE BATTERY CASE OR COVER
    b. LEAKAGE, OR EVIDENCE OF OVERFILLING
    c. TIGHTNESS OR LOOSENESS OF HOLD-DOWN CLAMPS
    d. BUILD-UP OF ACID SALTS AROUND TERMINALS AND CLAMPS
    e. BAD CONTACTS OF BATTERY AND CABLES
4. CORRECTIVE MEASURES CAN BE TAKEN TO OVERCOME SOME OF THESE CONDITIONS

1. BATTERY CLEANING

1. MOISTURE FORMS ON TOP OF THE BATTERY WHEN ELECTROLYTE ESCAPES BATTERY CELLS IN FORM OF A SPRAY
2. THIS MOISTURE COLLECTS DUST AND DIRT AS WELL AS CAUSING THE FORMATION OF ACID SALTS AROUND THE BATTERY TERMINALS AND CLAMPS
3. A CONVENIENT WAY TO CLEAN THE BATTERY IS:
    a. TIGHTEN FILL CAPS AND PLUG VENTS WITH TOOTHPICKS
    b. SPRINKLE OR BRUSH A BAKING SODA SOLUTION (BAKING SODA AND WATER IN A PASTE FORM) ON BATTERY TERMINALS, CLAMPS, AND TOP
    c. WAIT FOR FOAMING TO STOP-THE SODA, BEING A BASE, REACTS WITH THE ACID SALTS TO NEUTRALIZE THEM
    d. FLUSH OFF WITH CLEAN WATER
4. REMOVE THE TERMINAL CABLES AND CLEAN

a. CLEAN CONTACT AREAS OF CABLE SOCKETS AND TERMINAL POSTS WITH SPECIAL WIRE BRUSHES
b. APPLY A COAT OF PETROLEUM JELLY ON CLAMPS AND POSTS TO RETARD CORROSION AND ACID SALT BUILD-UP

5. CLEAN AND ADJUST THE HOLD-DOWN CLAMPS
   a. CLEAN WITH WIRE BRUSHES AND APPLY COAT OF PETROLEUM JELLY SIMILAR TO ABOVE (4.b)
   b. TIGHTEN LIGHTLY TO PREVENT BATTERY FROM MOVING OR FROM BOUNCING AROUND
   c. AVOID OVER TIGHTENING-THIS MAY CAUSE THE BATTERY CASE TO WARP, BULGE, OR EVEN CRACK

2. BATTERY CHARGING

1. A BATTERY SHOULD NOT BE LEFT IN A DISCHARGED CONDITION
2. IF LEFT IN THIS STATE, THE LEAD SULFATE OF THE PLATES HARDENS AND IS DIFFICULT TO RESTORE TO LEAD AND LEAD DIOXIDE
3. THE WATERY SOLUTION OF THE ELECTROLYTE ALSO MAKES IT MORE SUSCEPTIBLE TO FREEZING IN COLD WEATHER
4. A BATTERY IS CHARGED BY FORCING A CURRENT THROUGH IT IN THE OPPOSITE DIRECTION OF THE CURRENT PRODUCED BY THE BATTERY
5. THIS REVERSES THE CHEMICAL ACTION THAT TOOK PLACE WHEN THE BATTERY WAS FURNISHING ENERGY AND RESTORES THE PLATES TO THEIR ORIGINAL STATE
6. A D.C. GENERATOR ON THE AUTOMOBILE DOES THIS WHEN THE CAR IS RUNNING
7. THE TWO TYPES OF BATTERY CHARGES MOST USED TODAY ARE:
   a. FAST CHARGE
   b. SLOW CHARGE

NOTE: FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR OPERATING VARIOUS CHARGERS

8. GENERAL PROCEDURE FOR THE FAST CHARGE:
   - a. PUT SWITCH IN "OFF" POSITION
   - b. CHECK BATTERY FOR PROPER LEVEL ELECTROLYTE - REPLACE FILL CAP BUT DO NOT TIGHTEN
   - c. CONNECT LEADS-POSITIVE TO PLUS (+) TERMINAL; NEGATIVE TO MINUS (-) TERMINAL
   - d. SELECT VOLTAGE - SET SELECTOR SWITCH FOR 6 OR 12 VOLTS
   - e. SET TIMER SWITCH AS PER CHART

| BATTERY CONDITION | TIME OF CHARGE |
|---|---|
| DEAD | 55 MINUTES |
| 1/4 CHARGED | 45 MINUTES |
| 1/2 CHARGED | 30 MINUTES |
| 3/4 CHARGED | USE SLOW CHARGE |

   - f. TURN SWITCH TO "ON"

NOTE: THE CHARGING RATE WILL AUTOMATICALLY BE REDUCED TO SLOW CHARGE WHEN TIMER EXPIRES

9. GENERAL PROCEDURE FOR THE SLOW CHARGE
   - a. CONNECT CHARGER AS PER STEPS 8 a., b., c., d., e., f.
   - b. SET AMPERAGE RATE TO 1 AMP FOR EACH POSITIVE PLATE WITHIN A CELL

EXAMPLE: A 21 PLATE CELL HAS 10 POSITIVE PLATES. SET RATE 10 AMPS. TEN AMP RATE REQUIRES ABOUT 24 HOURS

   - c. CHECK FREQUENTLY WITH A HYDROMETER; WHEN GRAVITY READING CEASES TO RISE, THE BATTERY IS FULLY CHARGED

10. CAUTION: AN OVERCHARGED BATTERY OR TOO HIGH A CHARGING RATE CAN SERIOUSLY DAMAGE A BATTERY BY:

a. OVERHEATING
b. CAUSING A GAS BUBBLE FORMATION INSIDE THE SPONGY PLATE MATERIALS FORCING PARTICLES OF ACTIVE MATERIALS TO BREAK AWAY FROM THE PLATE

NOTE: ALL THE BATTERY CHARGING SHOULD BE DONE IN A WELL VENTILATED AREA

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

SIMPLE RECALL QUESTIONS:

| | | |
|---|---|---|
| 1. | _____ CELLS ARE THOSE IN WHICH ELECTRON TRANSFER IS NOT READILY REVERSIBLE. | PRIMARY |
| 2. | THE POSITIVE TERMINAL WHERE ELECTRONS ENTER A DEVICE IS CALLED THE _____. | CATHODE |
| 3. | IN SECONDARY CELLS, THE ELECTRO-CHEMICAL ACTION IS _____. | REVERSIBLE |
| 4. | LEAD BATTERY CELLS EACH PRODUCE APPROXIMATELY _____ VOLTS OF E. M. F. | TWO (2) |
| 5. | SIX CELLS CONNECTED IN _____ PRODUCE TWELVE VOLTS TOTAL. | SERIES |
| 6. | SEVERAL BATTERY PLATES WELDED TO A PLATE STRAP IS CALLED A PLATE _____. | GROUP |
| 7. | PLATE GROUPS ARE INTERLEAVED TO FORM AN _____. | ELEMENT |
| 8. | THE _____ PLATE GROUP CONTAINS ONE ADDITIONAL PLATE. | NEGATIVE |
| 9. | THE CELL ELEMENT IS ACTIVATED WITH THE INTRODUCTION OF THE _____. | ELECTROLYTE |
| 10. | THE BATTERY MOST COMMONLY USED IN THE AUTOMOBILE IS THE _____ TYPE STORAGE BATTERY. | LEAD-ACID |
| 11. | BATTERIES ARE RATED BY THEIR _____ AND AMPERAGE HOUR CAPACITY. | VOLTAGE |
| 12. | THE _____ MEASURES SPECIFIC GRAVITY. | HYDROMETER |

13. ACID SALTS ARE BEST CLEANED FROM THE BATTERY WITH A SOLUTION OF _____ AND WATER. BAKING SODA

14. _____ WATER SHOULD BE ADDED TO THE ELECTROLYTE WHEN NECESSARY. DISTILLED

15. THE AMPERAGE RATE FOR A 17 PLATE PER CELL BATTERY SHOULD BE _____. 8

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED.)

TRUE - FALSE

1. STORAGE BATTERIES DO NOT STORE ELECTRICAL ENERGY. T
2. ACTIVE MATERIALS WITHIN THE BATTERY REACT ELECTRICALLY TO PRODUCE CURRENT. F
3. THE BASIC UNIT OF THE AUTOMOBILE STORAGE BATTERY IS THE CELL. T
4. THE CELL IS COMPOSED OF POSITIVE AND NEGATIVE PLATES SUSPENDED IN ELECTROLYTE. T
5. THERE IS ALWAYS ONE MORE POSITIVE PLATE THAN NEGATIVE PLATE IN EACH CELL. F
6. EACH CELL PRODUCES APPROXIMATELY 2 VOLTS E.M.F. REGARDLESS OF SIZE. T
7. IT REQUIRES SIX CELLS HOOKED IN PARALLEL TO MAKE A 12 VOLT BATTERY. F
8. THE ELECTROLYTE USED IN A LEAD-ACID STORAGE BATTERY IS COMPOSED OF 36% HYDROCHLORIC ACID AND 64% DISTILLED WATER. F
9. THE THREE BASIC INSTRUMENTS FOR CHECKING A BATTERY ARE A HYDROMETER, THERMOMETER, AND AMMETER. F
10. THE SPECIFIC GRAVITY OF A FULLY CHARGED BATTERY IS 1.270. T
11. HEAT AFFECTS THE WEIGHT OF ELECTROLYTE'S SPECIFIC GRAVITY TO THE RATIO OF .004 LBS. PER EACH 10°. T
12. THE ACCEPTED STANDARD FOR MEASURING SPECIFIC GRAVITY IS 80° F. TEMPERATURE. T
13. HIGHER TEMPERATURES CAUSE THE ELECTROLYTE TO BECOME HEAVIER AND MORE CONCENTRATED. F

14. WATER SERVES TO COOL AND THIN THE ELECTROLYTE, BUT NOT REDUCE ITS EFFICIENCY. F

15. WHENEVER ELECTRICAL TROUBLE OCCURS, ONE OF THE FIRST CONSIDERATIONS IS THE BATTERY. T

16. ONE OF THE BEST METHODS OF CLEANING BATTERIES IS TO BRUSH ON A SOLUTION OF BAKING SODA AND WATER, ALLOW THE FOAMING TO STOP, AND RINSE CLEAN WITH WATER. T

17. BATTERIES ARE RATED BY THEIR VOLTS AND AMP-HOURS. T

18. AMP - HOURS ARE DETERMINED BY THE AMOUNT OF AMPS IT CAN MAINTAIN FOR 20 HOURS AT 80° F. T

19. AN 80 AMP - HOUR BATTERY CAN PRODUCE 8 AMPS FOR 80 HOURS. F

20. BATTERIES BEING STORED SHOULD BE STORED IN A DISCHARGED STATE. F

21. GASES FORMED DURING BATTERY CHARGING ARE VERY EXPLOSIVE. T

22. A BATTERY WITH ELECTROLYTE THAT IS 15% ACID AND 85% WATER IS ABOUT ONE-THIRD CHARGED. F

23. THE ELECTROLYTE SHOULD COVER THE BATTERY PLATES APPROXIMATELY 3/8". T

24. BATTERY CHARGING SHOULD BE DONE IN A WELL VENTILATED AREA. T

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## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

THE SECONDARY CELL IS THE BASIC UNIT OF THE STORAGE BATTERY. SECONDARY MEANS RECHARGABLE. IT IS COMPOSED OF TWO GROUPS OF METAL PLATES SAID TO POSSESS CHEMICAL ENERGY; ONE GROUP POSITIVELY, ONE GROUP NEGATIVELY. THESE PLATES ARE INTERLEAVED AND HELD IN PLACE BY SEPARATORS AND EACH GROUP FASTENED TOGETHER WITH A STRAP. THE CELL IS ACTIVATED BY THE ADDITION OF AN ELECTROLYTE, A LIQUID CONDUCTOR.

MOST AUTOMOBILES USE THE LEAD-ACID CELL BATTERY. THE PLATES ARE COMPOSED OF LEAD COMPOUNDS AND THE ELECTROLYTE OF A SOLUTION OF SULPHURIC ACID AND WATER. THESE REACT TO FORM NEW COMPOUNDS WHILE RELEASING ELECTRONS TO CREATE ELECTRICAL ENERGY.

MAINTAINING THE CORRECT SPECIFIC GRAVITY AND FLUID LEVEL OF THE ELECTROLYTE ARE THE KEY FACTORS OF KEEPING THE STORAGE BATTERY IN GOOD CONDITION. THE LEVEL OF ELECTROLYTE SHOULD BE CHECKED AND MAINTAINED EACH TIME THE HOOD IS RAISED. ALSO, A QUICK VISUAL CHECK OF THE BATTERY CASE, TERMINALS, LEADS, AND CLAMPS WILL INDICATE ANY ADJUSTMENTS OR CLEANING NECESSARY. SPECIFIC GRAVITY SHOULD BE CHECKED ONCE A MONTH OR IF BATTERY DOES NOT PRODUCE EFFICIENTLY, AND SHOULD BE MAINTAINED AT 1.270 AT 80°F. ADJUSTED READING OF .004 FOR EACH 10° F. DIFFERENTIATION IS WARRANTED AS SPECIFIC GRAVITY IS AFFECTED BY TEMPERATURE. THE BEST METHOD FOR CLEANING IS BRUSHING ON A SOLUTION OF BAKING SODA AND WATER. THIS REACTS WITH ACID SALT FORMATION, NEUTRALIZING AND DISSOLVING THEM. RINSE WITH FRESH WATER.

RECHARGING IS ACCOMPLISHED BY FORCING A CURRENT BACK THROUGH THE BATTERY IN REVERSE OF ITS NORMAL DISCHARGE. THIS REVERSES THE CHEMICAL ACTION, RESTORING THE CELL PLATES TO THEIR ORIGINAL CONDITION. BATTERY CHARGERS ACCOMPLISH THIS. BATTERY MANUFACTURERS' SPECIFICATIONS AND CHARGER MANUFACTURERS' INSTRUCTIONS SHOULD BE FOLLOWED. SLOW CHARGES ARE GENERALLY AT A RATE OF 10% OF AMP-HOUR RATING AND REQUIRE 20-24 HOURS FOR A CHARGE. THIS SHOULD BE DONE IN A WELL VENTILATED AREA, AND THE BATTERY CHECKED FREQUENTLY WITH A HYDROMETER TO PREVENT OVERCHARGING. THE LEAD STORAGE CELL PRODUCES 2 VOLTS. IN SERIES, CELL VOLTAGES ADD; IN PARALLEL, CELL VOLTAGES HAVE THE SAME E. M. F.

SUGGESTED READING FOR THE STUDENTS:
AUTOMECHANICS, CH. 8

THE NEXT LESSON IS: VIII-C-5(I), "AUTOMOTIVE ENGINE TUNE-UP"

# INFORMATION SHEET
# ON
# ENGINE TROUBLE DIAGNOSIS

SUBJECT: **Pressure Gauges**

INTRODUCTORY INFORMATION:

Measuring devices of one kind or another have been used since the beginning of time and will continue to be used until the end of time.

The cave man judged distances by eye or by time. He compared sizes by places or by matching objects with trees, stones, or other objects that he knew from memory. He knew temperature was cold, warm, or hot only by touch. His body literally became his own yardstick, or measuring device. Seeing that his basic needs required no degree of accuracy, his arms, legs, feet, hands, and fingers were used to measure his clothing, weapons and other necessities. He worked alone and had his own methods for measuring, and consequently no standards were ever set.

The caveman was not faced with the need for the close tolerances and the precision required on the thousands of parts found in the modern automobile. In mass production industries, where items are made by the millions, measurements have to be within the design tolerances. No guesswork is allowed. The service technician in the automotive shop must also work with exact measurements. To do this he must use precision measuring devices while performing his daily job.

While we must still continue to use our senses for rough approximations in certain situations and will find them helpful in diagnosis of trouble, greater and greater precision in modern automobiles has led to a need for precise measuring devices and the ability to use them correctly.

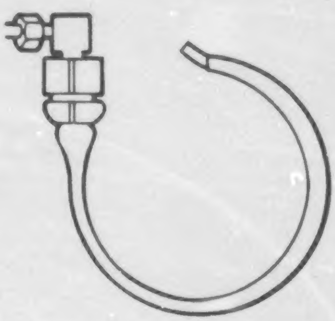
## GENERAL INFORMATION

Several different kinds of pressure gauges for measuring air and gas, liquids, and vacuums are in use today, such as the dial-type pressure gauge and stem-type tire pressure gauge.

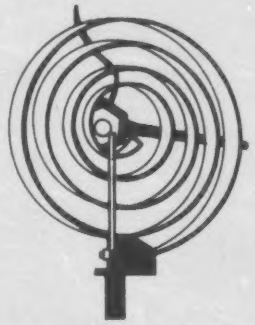
The stem-type tire pressure gauge consists basically of a springloaded plunger and a measuring rod scaled off in pounds per square inch of pressure.

Bourdon tube - Dial-type pressure gauges are used on various pieces of shop equipment, such as oxygen and acetylene tanks, engine-cylinder compression gauges, air-conditioning charging stations, air compressors and many others. There are several different types of dial-type pressure gauges currently available, but the type most commonly used is the Bourdon tube gauge.

Basically, the Bourdon tube gauge consists of a curved, hollow tube connected to a pointer through a lever and gear mechanism. When the pressure in the system being checked enters the Bourdon gauge, it also enters the curved, hollow tube. As the pressure increases, the curved, hollow tube tends to straighten. The tube is connected to a lever and gear mechanism and cannot straighten but moves slightly and pulls the lever. Movement of the lever turns a sector, and the sector rotates a small gear. As the small gear is rotated, it moves the needle on the dial to indicate the amount of pressure in the system. Most Bourdon tube gauges are calibrated in pounds per square inch.

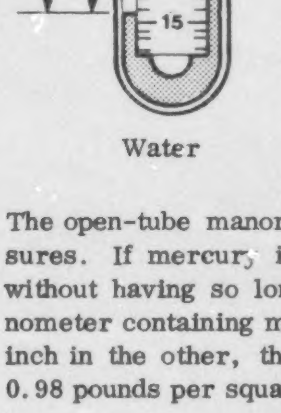


C-shaped Bourdon tube



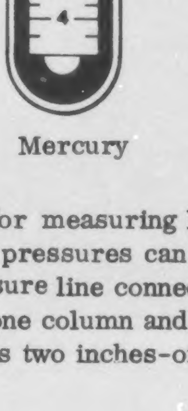
Spiral Bourdon tube

Manometer - A more accurate means of measuring air pressure in the automotive shop is with the use of the manometer. The manometer is the simplest device for measuring pressure, and the simplest form of the manometer is the U-tube. This consists of a glass or plastic tube shaped like the letter U and a scale marked in inches and tenths of inches with the zero mark in the center. When the air-pressure line is connected to the manometer, the liquid is pushed downward in one arm of the tube and upward in the other arm. The amount of pressure being measured is then shown by the difference in height of the liquid in the two colums.



Water

Difference in height of liquid in columns



Mercury

The open-tube manometer, containing water, is used for measuring low air pressures. If mercury is substituted for the water, higher pressures can be measured without having so long a tube. For example, if a pressure line connected to a manometer containing mercury lowers the fluid one inch in one column and raises it one inch in the other, the inlet line pressure is expressed as two inches-of-mercury or 0.98 pounds per square inch.

If water is used as the manometric fluid, the same pressure would cause the water to be lowered 13.58 inches in one column and raised 13.58 inches in the other. The pressure would then be expressed as 27.16 inches-of-water.

For still higher pressures, the closed-tube manometer, containing mercury, is used. In the closed-tube-type manometer, the air is compressed in the sealed end of the tube, permitting a much higher pressure reading. A scale may be used with either type manometer. This may be calibrated in either inches of mercury, inches of water or in pounds per square inch.

Most pressure gauges used in the automotive shop measure only the pressure above atmospheric. Therefore, they read zero at atmospheric pressure. To obtain the true or absolute pressure, the local atmospheric pressure -- which is dependent upon the elevation of the area -- must be added to the gauge pressure. This atmospheric pressure is 14.7 pounds per square inch at sea level. However, some type gauges are designed to indicate pressures lower than atmospheric pressure. This gauge is called a vacuum gauge. Vacuum-gauge dials are marked in inches of mercury to correspond with the "U" - tube manometer used in the laboratories during calibration.

Vacuum gauges, when used properly, will provide considerable useful information about the interior condition of the automobile engine. However, it is easy to misinterpret the reading of the vacuum gauge, and in doing so, a false conclusion regarding the trouble will result.

A vacuum gauge can be used to check for such things as ignition timing, carburetor adjustments, improper valve action, cylinder leakage, and many others. In using a vacuum gauge on an engine, it is very important to note the action of the gauge needle, more so than how much vacuum can be obtained.

Usually, if the engine is in good internal condition and properly adjusted, the vacuum gauge needle will hold steady at a reading of between 17 and 21 inches of mercury at idle speed. There will be, of course, some variation to this rule with changes in altitude and atmospheric conditions. As an example, an eight-cylinder engine will ordinarily have a reading slightly higher than a six-cylinder engine; and a six-cylinder engine, slightly higher than a four-cylinder. Also, for every 1,000 feet above sea level, the reading on the vacuum gauge will be lowered approximately one inch.

Before using the vacuum gauge, it is extremely important to read the manufacturer's instructions and be thoroughly familiar with the vacuum-gauge operation.

# INFORMATION SHEET
# ON
# ENGINE TROUBLE DIAGNOSIS

VIII-C-2(IS)

SUBJECT: Cylinder Compression and Manifold Vacuum Tests

## INTRODUCTORY INFORMATION:

As manufacturers continue to improve engine design, engines have decreased greatly in size, yet increased in power output. This calls for closer clearances, finer fits, and more accurate adjustments for the maintenance of satisfactory engine performance.

Fine adjustments necessary for peak running condition are obviously futile if the engine has major internal defects. Therefore, one of the first checks made is to detect evidence of leaking piston rings, faulty valves or valve timing, leaking or loose bearings, or worn camshafts lobes.

## GENERAL INFORMATION:

One of the first steps of engine tune-up is to make sure each cylinder has compression pressure within the range specified by the engine manufacturer. It is also important to note pressure variation between cylinders as this variance will have a more adverse effect upon engine performance than overall readings of slightly below specifications. Cylinders with readings within ten pounds of each other are not likely to be noticeable in the performance of the engine. If the pressure variation exceeds ten pounds above normal, the heads should be removed and the carbon scraped from all surfaces of the combustion chamber. The problem in this case being a reduction of volume in the combustion chamber resulting from carbon build-up.

Readings below normal indicate loss of compression past the valves, piston rings, or through a leaking gasket. If pressure is increased after placing a small amount of oil in cylinders having low readings, the problem is probably with worn piston rings. If readings remain steady and low, the problem is likely a loss of pressure past the valves. In either case, an abnormal loss of compression requires the removal of cylinder heads to make an accurate diagnosis.

Intake Manifold Vacuum. The vacuum gauge is another very important engine tester. In the hands of an experienced operator, it can provide considerable useful information about the condition of internal parts of the engine. Vacuum tests are made and the readings used in three different ways: as a preliminary test before any corrections are made, as a final test to prove the effectiveness of corrections, and to adjust the carburetor. When properly used and understood, the vacuum gauge will indicate the following defects:

Improper valve action
Restricted exhaust system

Cylinder leakage
Intake system leakage
Ignition timing
Ignition defects
Incorrect carburetor adjustment

The vacuum gauge is usually connected to the intake manifold at the windshield wiper connection. The needle indicator is then closely observed while the engine runs at idle speed. Normal vacuum reading is between 17 and 20. The following interpretations apply to most engines.

Normal and steady -- a fair indication that little of anything is wrong with engine operation at that particular speed and load condition.

Low and steady -- indicates a power reduction caused by late ignition or valve timing, or a loss of compression.

Very low -- intake manifold, carburetor spacer or head gasket leak.

Oscillations of the needle, increasing with engine speed -- partial or complete loss of power in one or more cylinders caused by a leaky head or manifold gasket, burnt valve, weak valve spring, or a defect in the ignition system.

Gradual drop in reading at idle speed -- excessive back pressure in exhaust system, generally caused by clogged line.

Intermittent fluctuation-- defect in ignition system or sticking valve.

Slow fluctuation or drifting of the needle -- excessively rich air-fuel mixture or restricted crankcase ventilation system.

VIII-C-3(IS)

# INFORMATION SHEET
# ON
# IGNITION SYSTEM

SUBJECT: Isolating Ignition Problems on the Vehicle

## INTRODUCTORY INFORMATION:

At times it is more expedient to perform ignition system tests on the vehicle in order to save time and cash outlay for the customer and perform needed service for the vehicle in a more effective and efficient manner.

Performing tests, adjustments, or repairs for the ignition system is to cause the engine to operate with maximum acceleration, power, and economy of fuel. Too, a good operating engine will maintain the required exhaust emission levels. When performing tests, adjustments, and repairs for the ignition system it is essential to follow the procedures and specifications laid down by the manufacturer. Refer to the master parts catalog for parts usage and interchangeability before replacing a distributor or a component part for a distributor.

## GENERAL INFORMATION:

The ignition system consists of a primary (low voltage) and a secondary (high voltage) circuit.

The primary circuit consists of the:

1. Battery
2. Ignition switch
3. Primary circuit resistance wire
4. Primary windings of the ignition coil
5. Breaker points
6. Condenser

The secondary circuit consists of the:

1. Secondary windings of the ignition coil
2. Distributor rotor
3. Distributor cap
4. High tension (spark plug) wires
5. Spark plugs

When the breaker points are closed, current flows from the battery through the ignition switch to the primary windings in the coil, then to ground through the closed breaker points. When the breaker points open, the magnetic field built up in the primary windings of the coil moves through the secondary windings of the coil, producing high voltage. High voltage is produced each time the breaker points open.

The high voltage flows through the coil high tension lead to the distributor cap where the rotor distributes it to one of the spark plug terminals in the distributor cap. This process is repeated for every power stroke of the engine.

Ignition system troubles are caused by a failure in the primary and/or the secondary circuit; incorrect ignition timing; or incorrect distributor advance. Circuit failures may be caused by shorts, corroded or dirty terminals, loose connections, defective wire insulation, cracked distributor cap or rotor, defective distributor points, fouled spark plugs, or by improper dwell angle.

If an engine's starting or operating trouble is attributed to the ignition system, start the engine and verify the complaint. On engines that will not start, be sure there is gasoline in the fuel tank and that fuel is reaching the carburetor. Then locate the ignition system problem by an oscilloscope test or by spark intensity test.

## Primary and Secondary Spark Intensity Test

Trouble Isolation. Connect an auxiliary starter switch into the starting circuit. Remove the coil high tension lead from the distributor cap tower. Turn the ignition switch to the on position. Use high tension wire pliers and hold the distributor end of the coil high tension lead approximately 3/16 inch from a cylinder head or any other good ground and crank the engine over with the auxiliary starter switch.

If the spark is good, the trouble lies in the primary circuit.

If there is no spark or a weak spark, the trouble is in the secondary circuit, coil to distributor high tension lead, or the coil.

Primary circuit. A breakdown or energy loss in the primary circuit can be caused by: defective primary wiring of loose or corroded terminals; burned, shorted, sticking, or improperly adjusted breaker points; or an open or shorted coil or condenser.

A complete test of the primary circuit consists of checking the circuit from the battery to the coil, resulting in hard starting and poor performance.

To isolate a trouble in the primary circuit, use a voltmeter and perform the following tests; battery to coil; starting ignition circuit; resistance wire; coil to ground; or breaker points.

Secondary circuit. A breakdown or energy loss in the secondary circuit can be caused by: fouled or improperly adjusted spark plugs; defective high tension wiring; or high tension leakage across the coil, distributor cap, or rotor resulting from an accumulation of dirt.

To check the spark intensity at the spark plugs, thereby isolating an ignition problem to a particular cylinder, proceed as follows:

CAUTION: This test is not to be performed with an electronic ignition system.

Check the spark intensity of one spark plug wire at a time. Disconnect a spark plug wire. Install a terminal adapter in the terminal of the wire to be checked. Use high tension wire pliers and hold the adapter approximately 3/16 inch from the exhaust manifold or any good ground. Crank the engine over with an auxiliary starter switch. The spark should jump the gap regularly. If the spark intensity of all the wires is satisfactory, the coil, condenser, rotor, distributor cap, and secondary wires are probably satisfactory.

If the spark is good at only some wires, check the resistance of those particular leads.

If the spark is equal at all wires, but weak or intermittent, check the coil, distributor cap, and the coil to distributor high tension wire. The wire should be clean and bright on the conducting ends and on the coil tower and distributor sockets. The wire should fit snugly and be bottomed in the socket.

Battery to coil voltmeter test. Connect a voltmeter between the positive post of the battery and the primary terminal of the coil. Connect a jumper wire from distributor terminal of the coil to a good ground on the distributor housing. All lights and accessories are to be off. Turn the ignition switch to the on position. If the voltmeter reading is between 4.5 and 6.9 volts, check the following:

The battery and cables for loose connections or corrosion. The primary wiring for worn insulation, broken strands, and loose or corroded terminals.

If the voltmeter reading is less than 4.5 volts, the ignition resistance wire should be replaced.

Check the starter relay to ignition switch for damage.

Starting ignition circuit voltmeter test. Connect a voltmeter between the positive post of the battery and the primary terminal of the coil. Disconnect and ground the coil to distributor high tension lead at the distributor. The ignition switch is to remain in the off position. Use an auxiliary starter switch and crank the engine over. Observe the voltage drop on the voltmeter.

If the voltage drop is 0.4 volt or less, the starting ignition circuit is satisfactory.

If the voltage drop is greater than 0.4 volt, clean and tighten the terminals in the circuit or replace the wiring as necessary.

Ignition switch voltmeter test. Locate the point at which the ignition switch lead can be separated from the wiring harness. Refer to the vehicle wiring diagram to identify the ignition switch lead. The wiring harness will be color coded. Fabricate a jumper wire by pulling some insulation from the center of the wire. Affix a female connector to end of the jumper and a male connector to the opposite end. Insert the male connector in the harness and the female end on the switch lead. Connect a voltmeter between the bared part of the jumper and the primary terminal of the coil. Install a jumper wire from the distributor terminal of the coil to a good ground on the distributor body. All accessories and lights are to be off. Turn the ignition switch to the on position.

If the voltmeter reading is 0.3 volt or less, the ignition switch and the relay to switch wire are satisfactory.

If the voltmeter reading is greater then 0.3 volt, either the ignition switch and/or the wire is damaged.

Resistance wire voltmeter test. Locate the point at which the ignition switch lead can be separated from the wiring harness. Refer to the vehicle wiring diagram to identify the ignition switch lead. The wiring harness will be color coded. Fabricate a jumper wire by peeling some insulation from the center of the wire. Affix a female connector to one end of the jumper and a male connector to the opposite end. Insert the male connector in the wiring harness, and connect a voltmeter between the female end of the jumper and the primary terminal of the coil. Install a jumper wire from the distributor terminal of the coil to a good ground. All accessories and lights are to be off. Turn the ignition switch to the on position.

If the voltmeter reading is between 6.6 and 4.5 volts, the resistance wire is satisfactory.

If the voltmeter reading is greater than 6.6 volts or less than 4.5 volts replace the resistance wire. Disconnect all test equipment and connect all leads to proper terminals.

Coil to ground voltmeter test. Connect a voltmeter between a good ground and the primary terminal of the coil. Lift distributor cap, turn engine over, and close the breaker points. All lights and accessories are to be off. Refasten distributor cap in position on the distributor. Turn the ignition switch to the on position.

If the voltmeter reading is 0.25 volt or less, test the voltage drop between each of the following:

1. The coil and the breaker point connections of the coil to distributor primary wire.
2. The movable breaker point and the breaker plate.
3. The breaker plate and the distributor housing.

Disconnect the test leads and make all necessary connections.

Coil test. Check the amperage draw both with the engine idling and stopped. These checks should fall within specifications.

Other checks for the coil are to be made on a coil tester following the manufacturer's instructions. Check for ohms resistance both primary and secondary.

Secondary (high tension) wires resistance test. The secondary wires include the wires connecting the distributor cap to the spark plugs and the wire connecting the center terminal of the distributor cap to the center terminal of the ignition coil.

These wires are the radio resistance type which filter out the high frequency electrical impulses that are the source of ignition noise interference. The resistance of each wire should not exceed 1000 ohms per inch. When checking the resistance of the wires or setting ignition timing, do not puncture the wires with a probe. The probe may cause a separation in the conductor.

When removing the wires from the spark plugs, grasp and twist the moulded cap, then pull the cap off the spark plug by hand only. Do not pull on the wire because the wire connection inside the cap may become separated or the insulator may be damaged.

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-5(I)

SUBJECT: AUTOMOTIVE ENGINE TUNE-UP

AIM: THE STUDENT WILL BE ABLE TO EXPLAIN THE DIFFERENCE IN A MINOR AND A MAJOR TUNE-UP; THE NEED FOR EACH AND THE LIMIT AND/OR EXTENT OF EACH. THE STUDENT WILL BE ABLE TO FOLLOW A LOGICAL SEQUENCE OF TEST PROCEDURES, ADJUSTMENTS, AND/OR REPLACEMENTS OF PARTS IN ORDER TO TUNE AN AUTOMOBILE ENGINE.

TEACHING AIDS: TRANSPARENCIES I. ED. II 7T (USE TRANSPARENCIES IN PREVIOUS LESSONS AS REFERRED TO IN STAGE II, PRESENTATION, OF THIS LESSON) FILMSTRIP: ENGINE TESTS AND TUNE-UP (SEE BIBLIOGRAPHY) CHALKBOARD

MATERIALS: CHALK

PREREQUISITE EXPERIENCE OF THE LEARNER: THE STUDENT MUST HAVE SATISFACTORILY COMPLETED MAJOR BLOCKS II, II, VII, AND LESSON VIII-C-1(I)

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## I. PREPARATION (OF THE LEARNER-MOTIVATION)

TO MAINTAIN AN ENGINE AT PEAK PERFORMANCE AND ECONOMY, IT MUST BE KEPT IN GOOD CONDITION. ENGINE TUNE-UP IS ONE ANSWER TO KEEPING A CAR IN GOOD CONDITION. "TUNE-UP" MEANS DIFFERENT THINGS TO DIFFERENT PEOPLE. TO THE AVERAGE CAR OWNER IT MEANS THE CAR WILL RUN BETTER AND MORE SAFELY THAN IT DID BEFORE. TO THE MECHANIC IT IS THE RESULT OF WHATEVER ADJUSTMENTS AND/OR REPLACEMENTS OF PARTS NECESSARY TO RETURN THE ENGINE TO A LEVEL OF EFFICIENCY EXPECTED FOR AN ENGINE IN FIRST CLASS CONDITION. A TUNE-UP, THEN, DEPENDS ON THE EXTENT OF THE WORK REQUIRED TO RETURN THE ENGINE TO GOOD OPERATING CONDITION.

THE DRIVING PUBLIC, IN GENERAL, MAKES A CONSCIOUS EFFORT TO MAINTAIN THEIR VEHICLES IN A GOOD STATE OF OPERATING CONDITION FOR MANY REASONS-SAFETY, AVOID UNTIMELY BREAKDOWNS, ECONOMY. THIS MEANS THAT MOST CAR OWNERS BRING THEIR CARS IN PERIODICALLY FOR CHECKS AND ADJUSTMENTS. IN THE LONG RUN IT SAVES THEM DOLLARS AND HEADACHES AND INSURES A DEGREE OF PLEASANT, CAREFREE DRIVING.

MOST SHOPS, THEREFORE, OFFER TWO TYPES OF TUNE-UPS. A BASIC AND A COMPLETE TUNE-UP: MORE COMMONLY THESE ARE CALLED MINOR AND MAJOR TUNE-UPS. WHATEVER THE COVERAGE, IT IS IMPORTANT FOR THE CUSTOMER TO UNDERSTAND EXACTLY WHAT SERVICES ARE PROVIDED. A MINOR TUNE-UP CONSISTS OF ADJUSTING AND/OR REPLACING COMPONENTS OF

ENGINE AND ITS SUPPORTIVE SYSTEMS WHICH WEAR OUT OR ARE USED UP MORE RAPIDLY. SINCE THE LIFE OF THESE PARTS IS SHORTER, THE NECESSITY FOR A MINOR TUNE-UP OCCURS MORE FREQUENTLY. FOR THIS REASON, THE MINOR TUNE-UP IS DISCUSSED IN THIS LESSON PRIOR TO A COMPLETE OR MAJOR TUNE-UP.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. NEED FOR TUNE-UP | 1. THE INSTANT AN AUTOMOBILE IS DRIVEN FROM THE DEALER'S LOT, WEAR COMMENCES<br>2. AS THE CAR IS DRIVEN AND MILES ARE ADDED TO THE ODOMETER, WEAR WILL BEGIN TO APPEAR IN SLUGGISH PERFORMANCE AND POOR FUEL ECONOMY<br>3. THE ENGINE AND ITS SUPPORT SYSTEMS REQUIRE THE MOST ATTENTION-HENCE, ENGINE TUNE-UP<br>4. SOME PARTS WITHIN THE ENGINE AND ITS SUPPORT SYSTEMS WILL WEAR MORE RAPIDLY THAN OTHERS, AND ARE DESIGNED TO BE REPLACED AT PERIODIC INTERVALS<br>5. THESE PARTS ARE DESCRIBED AS "EXPENDABLE", WHICH MEANS "CONSUMED OR USED UP" AND GENERALLY ARE MORE ECONOMICAL TO REPLACE THAN REPAIR<br>6. PARTS WHICH FALL INTO THIS CLASSIFICATION ARE THE IGNITION POINTS, CONDENSER, AND SPARK PLUGS<br>7. REPLACEMENT OF THESE PARTS PLUS ADJUSTING ENGINE TIMING AND IDLE CONSTITUTE A MINOR TUNE-UP IN MOST SHOPS |
| B. WHEN TO TUNE-UP | 1. THIS IS ONE OF THE MOST DEBATED QUESTIONS IN AUTOMECHANICS AND ONE OF THE MOST DIFFICULT TO ANSWER<br>2. IT DEPENDS ON MANY FACTORS SUCH AS:<br>a. SIZE AND TYPE ENGINE |

   b. OPERATING CONDITIONS SUCH AS CITY DRIVING, WITH A LOT OF "STOP" AND "GO" TRAFFIC, OR MOSTLY HIGHWAY DRIVING: ROAD CONDITIONS AND LOAD CONDITIONS
   c. ENVIRONMENTAL CONDITIONS-HOT AND COLD, WET OR DRY AND DUSTY
   d. DRIVER TECHNIQUE SUCH AS THE "HOT ROD" TYPE, OR THE "LITTLE OLE LADY" TYPE

3. MANY MANUFACTURER'S MAKE RECOMMENDATIONS AS TO WHEN THEIR CARS ARE IN NEED OF A PARTICULAR SERVICE BASED ON THE AVERAGE FAMILY'S DRIVING HABITS AND TESTS THEY HAVE CONDUCTED
4. THERE IS NO SUCH AVERAGE FAMILY, AND DRIVING HABITS VARY WITH EACH CAR OWNER
5. CERTAINLY ONE WOULD NOT TUNE-UP AN AUTOMOBILE OPERATING EFFICIENTLY AT 10,000 MILES IF SERVICE WERE NEEDED AT 8,000 MILES
6. THE BEST ANSWER IS, "WHEN IT NEEDS IT", AND THIS BECOMES EVIDENT BY THE VEHICLE'S SLUGGISH SUB-STANDARD PERFORMANCE

C. PLEASING THE CUSTOMER

1. CUSTOMER SHOULD BE INFORMED AS TO EXACTLY WHAT SERVICES ARE RENDERED WITH A "BASIC TUNE-UP" WHEN REQUESTED
2. THIS WILL LIMIT MISUNDERSTANDING BY CUSTOMERS IF SERVICE BEYOND A MINOR TUNE-UP IS REQUIRED
3. EXPLAIN THAT REPLACING A MALFUNCTIONING PART MAY NOT IMPROVE ENGINE PERFORMANCE, OR MAY JUST TEMPORARILY IMPROVE PERFORMANCE AND THAT THE CAUSE OF THE MALFUNCTION MAY BE IN AN AREA COVERED IN A BASIC TUNE-UP

   EXAMPLE: WHY REPLACE IGNITION POINTS IF REGULATOR SETTING IS TOO HIGH ALLOWING EXCESSIVE VOLTAGE?

NEW POINTS WILL QUICKLY BURN, CUSTOMER WILL BE DISSATISIFIED AND BLAME SHOP FOR FAULTY WORK

4. CUSTOMER SHOULD BE CONTACTED AND NOTIFIED IF WORK BEYOND THAT REQUESTED IS FOUND TO BE NEEDED

D. MINOR TUNE-UP

1. ALSO CALLED BASIC TUNE-UP
2. USUALLY CONSISTS OF CHANGING/REPLACING IGNITION POINTS, CONDENSER, SPARK PLUGS AND ADJUSTING ENGINE TIMING AND IDLE
3. SERVICE/REPLACE SPARK PLUGS
4. REMOVE AND REPLACE THE IGNITION POINTS AND CONDENSER
5. CHECK AND ADJUST THE DISTRIBUTOR POINTS ANGLE OF DWELL AND TIMING
6. ADJUST CARBURETOR IDLE

E. MAJOR TUNE-UP

1. MEANS CHECKING ALL PHASES OF ENGINE OPERATION AND MAKING ANY ADJUSTMENTS, REPAIRS, AND REPLACEMENTS NECESSARY FOR PROPER ENGINE PERFORMANCE
2. MAJOR TUNE-UP DOES NOT MEAN REBUILDING THE ENGINE
3. ENGINE MUST BE IN SOUND MECHANICAL CONDITION TO RESPOND TO A TUNE-UP
4. PRELIMINARY CHECKS MAY SHOW THAT ENGINE NEEDS MECHANICAL WORK DONE BEFORE A SATISFACTORY TUNE-UP IS POSSIBLE
5. THREE REQUIREMENTS FOR ENGINE OPERATION ARE COMPRESSION, IGNITION, AND CARBURETION
6. THESE REQUIREMENTS NOT ONLY MUST BE MET BUT MUST BE ACCURATELY CONTROLLED AND REGULATED FOR OPTIMUM ENGINE PERFORMANCE

F. MAJOR TUNE-UP PROCEDURE

NOTE: THE FOLLOWING IS A SUGGESTED PROCEDURE FOR A MAJOR TUNE-UP AND MAY BE VARIED TO SOME EXTENT DEPENDING ON INDIVIDUAL

SHOP PRACTICES AND VEHICLE BEING TUNED

1. CLEAN, INSPECT, AND SERVICE STORAGE BATTERY
    - a. TEST BATTERY ELECTROLYTE
    - b. TEST CRANKING VOLTAGE
    - c. SERVICE STORAGE BATTERY
    - d. RETEST CRANKING VOLTAGE
2. TEST COMPRESSION AND/OR VACUUM
3. CHECK AND SERVICE IGNITION SYSTEM
    - a. REPLACE OR SERVICE SPARK PLUGS
    - b. INSPECT COIL
    - c. INSPECT PRIMARY WIRING AND SECONDARY CABLES AS IN PREVIOUS LESSON; REPLACE IF NECESSARY
    - d. INSPECT DISTRIBUTOR CAP AND ROTOR
    - e. REPLACE BREAKER POINTS AND CONDENSER
    - f. CHECK AND ADJUST DISTRIBUTOR ADVANCE MECHANISMS
    - g. CHECK AND ADJUST BREAKER POINTS ANGLE OF DWELL AND TIMING
    - h. LUBRICATE DISTRIBUTOR IF NECESSARY
4. INSPECT AND SERVICE CRANKING SYSTEM
    - a. LOAD TEST STARTER
    - b. TEST STARTING CIRCUITRY
    - c. CLEAN AND SERVICE STARTER AS REQUIRED
    - d. CLEAN, TEST, AND SERVICE STARTER SOLENOID IF REQUIRED
5. CHECK AND SERVICE CHARGING SYSTEM
    - a. TEST GENERATOR OR ALTERNATOR OUTPUT
    - b. TEST VOLTAGE REGULATOR
    - c. TEST CHARGING SYSTEM INSULATED AND GROUND CIRCUITS
    - d. TEST CHARGING VOLTAGE
6. CHECK AND SERVICE FUEL SYSTEM
    - a. CHECK FUEL LINES AND CONNEC-

TIONS, TANK, AND GAGE

b. TEST AND SERVICE FUEL PUMP AND FUEL FILTER

c. REMOVE AND SERVICE/REPLACE CARBURETOR AIR FILTER

d. REMOVE, INSPECT, AND REPLACE PCV VALVE

e. SERVICE THE CARBURETOR AS REQUIRED

f. CHECK AND SERVICE/REPLACE MANIFOLD HEAT CONTROL VALVE

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

QUESTIONS (SIMPLE RECALL)

| | |
|---|---|
| 1. THE FIRST STEP IN A MAJOR TUNE-UP IS TO CHECK AND SERVICE THE _____. | BATTERY |
| 2. TO RESPOND TO A TUNE-UP, THE ENGINE MUST BE _____. | MECHANICALLY SOUND |
| 3. THREE REQUIREMENTS FOR ENGINE OPERATION ARE COMPRESSION, IGNITION, AND _____. | CARBURETION |
| 4. A HYDROMETER IS USED TO CHECK SPECIFIC GRAVITY OF BATTERY _____. | ELECTROLYTE |
| 5. IT IS RECOMMENDED THAT THE _____ BE REPLACED EACH TIME THE IGNITION POINTS ARE REPLACED. | CONDENSER |
| 6. SPARK PLUGS IN GOOD CONDITION WILL HAVE NO PITS ON THE ELECTRODES AND WILL BE A _____ IN COLOR. | DULL GRAY |
| 7. CHARGING SYSTEM PROBLEMS CAN BE TRACED TO EITHER THE BATTERY, GENERATOR, REGULATOR, OR _____. | WIRING |
| 8. THE FIRST TEST CONDUCTED ON THE GENERATOR IS THE _____ TEST. | VOLTAGE OUTPUT |
| 9. ITEMS WHOSE SERVICE LIFE IS RELATIVELY SHORT AND MUST BE REPLACED REGULARLY ARE SAID TO BE _____. | EXPENDABLE |
| 10. SECONDARY WIRING SHOULD BE CHECKED FOR RESISTANCE WITH A/AN _____. | OHMMETER |

## III. APPLICATION (CON'T.)

FILMSTRIP: ENGINE TESTS AND TUNE-UP

a. SHOW FILMSTRIP
b. CLASS DISCUSSION ON FILMSTRIP

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE QUESTIONS

1. THE VOLTMETER IS USED TO MEASURE ELECTRIC PRESSURE. T
2. THE AMMETER IS USED TO MEASURE THE AMOUNT OF ELECTRICAL CURRENT FLOW. T
3. THE TACHOMETER MEASURES MILES PER HOUR. F
4. ELECTRICAL RESISTANCE IS MEASURED IN POUNDS PER SQUARE INCH. F
5. THE OSCILLOSCOPE IS USED TO TEST BATTERY ELECTROLYTE. F
6. THE TEST LIGHT IS TO TEST CIRCUIT CONTINUITY. T
7. THE AMMETER IS ALWAYS CONNECTED IN PARALLEL WITH A CIRCUIT FOR USE IN A TEST. F
8. THE VOLTMETER IS ALWAYS CONNECTED IN PARALLEL WITH A CIRCUIT FOR USE IN A TEST. T
9. THE TACHOMETER IS A POWER INDICATING INSTRUMENT. F
10. THE OHMMETER INDICATES DIRECTLY THE RESISTANCE IN A CIRCUIT TO WHICH IT IS CONNECTED. T
11. THE VOLTMETER NEEDS AN OUTSIDE SOURCE OF POWER FOR OPERATION. T
12. ALTERNATOR DIODES MAY BE CHECKED WITH A TEST LAMP. T
13. DISCONNECT THE BATTERY TERMINAL GROUND STRAP WHILE SETTING UP TEST EQUIPMENT. T
14. A FULLY CHARGED BATTERY AND A HIGH CHARGING RATE INDICATES A FAULTY CUT OUT RELAY. F
15. WHEN ADJUSTING THE CURRENT REGULATOR THE VOLTAGE REGULATOR MUST BE OPERATIVE. T
16. THE VOLTAGE REGULATOR UNIT MUST BE AT THE CORRECT OPERATING TEMPERATURE BEFORE TESTING OR ADJUSTING. T
17. IGNITION SECONDARY WIRING IS A LARGER CONDUCTOR THAN PRIMARY WIRING. F
18. THE CURRENT DRAW OF IGNITION INCREASES WITH ENGINE F

SPEED.

19. AUTOMATIC CHOKES ARE OPERATED BY A BIMETALLIC SPRING. T

20. THE CARBURETOR FLOAT SYSTEM CONTROLS THE ACTION OF THE NEEDLE VALVE. T

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V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE INSTANT A CAR IS DRIVEN FROM THE DEALER'S LOT IT STARTS TO WEAR OUT. SOME PARTS WEAR MORE RAPIDLY THAN OTHERS, HENCE THE NEED FOR DIFFERENT TUNE-UPS. THERE ARE TWO CLASSIFICATIONS OF TUNE-UP: A BASIC AND A COMPREHENSIVE TUNE-UP, MORE COMMONLY CALLED A MINOR AND A MAJOR TUNE-UP.

THE MINOR TUNE-UP IS INTENDED TO RECONDITION (REPLACE) AND ADJUST PARTS OR COMPONENTS WHICH WEAR MORE RAPIDLY. A MINOR TUNE-UP CONSISTS OF REPLACING IGNITION POINTS, CONDENSER, AND SPARK PLUGS AND ADJUSTING ENGINE TIMING AND CARBURETOR IDLE. THIS TUNE-UP IS GENERALLY CONDUCTED ON A SEMI-REGULAR BASIS, EVERY 8,000-12,000 MILES, DEPENDING ON THE TYPE SERVICE THE VEHICLE PERFORMS AND THE CONDITIONS UNDER WHICH IT PERFORMS.

THE MAJOR TUNE-UP MEANS CHECKING ALL PHASES OF ENGINE OPERATION AND MAKING ANY ADJUSTMENTS, REPAIRS, OR REPLACEMENTS NECESSARY FOR PROPER ENGINE PERFORMANCE. THIS DOES NOT MEAN REBUILDING THE ENGINE. THE ENGINE MUST BE IN SOUND MECHANICAL CONDITION BEFORE A SATISFACTORY TUNE-UP IS POSSIBLE.

A MAJOR TUNE-UP GENERALLY CONSISTS OF:

1. CLEAN, INSPECT, SERVICE STORAGE BATTERY
2. TEST ENGINE COMPRESSION AND/OR VACUUM
3. CHECK AND SERVICE IGNITION SYSTEM WHICH INCLUDES THE COILS AND BALLAST RESISTOR: PRIMARY AND SECONDARY WIRING: SPARK PLUGS, DISTRIBUTOR CAP, POINTS, CONDENSER, ROTOR, ANGLE OF DWELL AND TIMING; ADVANCE MECHANISMS
4. INSPECT AND SERVICE CRANKING SYSTEM WHICH INCLUDES STARTER MOTOR, SOLENOID, AND WIRING CIRCUITRY
5. INSPECT AND SERVICE CHARGING SYSTEM WHICH INCLUDES GENERATOR/ALTERNATOR OUTPUT, VOLTAGE REGULATION, SYSTEM INSULATED AND GROUND CIRCUITS
6. INSPECT AND SERVICE FUEL SYSTEM WHICH INCLUDES GAS TANK AND GAGE; FUEL LINES AND FILTER; FUEL PUMP; CARBURETOR AND AIR FILTER; PCV AND MANIFOLD HEAT CONTROL VALVE.

THE WORD "SERVICE" MEANS TO REPAIR OR REPLACE, AND SOUND JUDGEMENT ON BEHALF OF THE MECHANIC MUST BE EXERCISED TO BOTH PLEASE THE CUSTOMER AND BE PROFITABLE TO THE SHOP.

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SUGGESTED READING:

THE NEXT LESSON IS: VIII-C-6(I), "IGNITION AND COMBUSTION"

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

VIII-C-1(S)

**TASK:** TEST STORAGE BATTERY

**AIM:**

1. THE STUDENT WILL BE ABLE TO PREPARE AND ADJUST BATTERY TESTING EQUIPMENT IN PREPARATION FOR TESTING STORAGE BATTERY CONDITION.
2. THE STUDENT WILL BE ABLE TO MAKE NECESSARY STORAGE BATTERY TEST TO DETERMINE BATTERY CONDITION.
3. THE STUDENT WILL BE ABLE TO INTERPRET STORAGE BATTERY TEST RESULTS AND MAKE JUDGMENTS AND DECISIONS CONCERNING NECESSARY STEPS TO TAKE IN BATTERY SERVICE OR REPLACEMENT.

**TOOLS AND EQUIPMENT:** HYDROMETER, BATTERY STARTER TESTER, BATTERY CHARGER

**MATERIALS:** BATTERY WATER, CLEAN RAGS

**TEACHING AIDS:** MANUFACTURER'S SPECIFICATIONS, HYDROMETER CONVERSION TABLE

**REFERENCES:**
AUTOMECHANICS, CH. 18
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450
AUTOMOTIVE MECHANICS, CHS. 13, 23

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE PERFORMED THE TASK OF SERVICING THE STORAGE BATTERY AND MADE PRELIMINARY PREPARATIONS BY STUDYING THE RECOMMENDED REFERENCES.

**CHECKING STANDARDS:**

1. MAINTAIN SAFE WORKING HABITS.
2. SELECTION OF PROPER TOOLS AND EQUIPMENT.
3. MAINTAIN CRAFTSMANLIKE PROCEDURES FOR PERFORMING TASKS.
4. HAVE AN APPRECIATION FOR TOOLS AND EQUIPMENT AND CUSTOMER'S VEHICLE.

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THERE ARE NINE APPARENT REASONS WHY A BATTERY WILL GO BAD OR NEED IMMEDIATE ATTENTION: INSUFFICIENT ELECTROLYTE, MECHANICAL DAMAGE, OVERHEATING, OVERCHARGING, BUCKLED PLATES, FREEZING, VIBRATION, CORROSION, AND BATTERY REJUVENATORS, OTHERWISE KNOWN AS "DOPES".

## I. PREPARATION (CON'T.)

THE MECHANIC MUST POSSESS A FULL KNOWLEDGE OF THE STORAGE BATTERY. NO DIAGNOSIS OF THE AUTOMOBILE ENGINE AND ITS ACCESSORIES CAN BE COMPLETE WITHOUT FIRST ANALYZING THE BATTERY CONDITION. A BATTERY TO BE FULLY SERVICEABLE MUST BE FULLY CHARGED.

## II. PRESENTATION (OF THE MATERIAL)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. VISUAL INSPECTION | 1. BATTERY CABLES<br>a. INSULATION IN GOOD CONDITION<br>b. TERMINALS NOT DEFORMED, BROKEN, OR CORRODED BADLY<br>2. BATTERY<br>a. CASE NOT CRACKED OR WORN THROUGH FROM VIBRATION<br>b. TERMINALS NOT DEFORMED, BROKEN, CORRODED, OR LOOSE IN THE CASE<br>3. BATTERY BOX AND THE HOLD DOWN IN GOOD CONDITION |
| 2. ANALYZE ELECTROLYTE | 1. WEAR GOGGLES<br>2. REMOVE BATTERY CAPS<br>3. SQUEEZE BULB OF HYDROMETER<br>4. INSERT RUBBER TIP END IN CELL<br>5. RELEASE BULB, ALLOW SOME ELECTROLYTE TO ENTER BARREL<br>a. GOOD ELECTROLYTE IS CLEAN AND CLEAR<br>b. BROWN OR REDDISH ELECTROLYTE INDICATES POSITIVE PLATE TROUBLES<br>(1) WORN OUT FROM LACK OF WATER<br>(2) FREEZING<br>(3) SHORT CIRCUIT<br>c. MILKY WHITE ELECTROLYTE<br>(1) MADE BY SMALL AIR BUBBLES<br>(2) GENERATOR IS OVERCHARGING BATTERY<br>d. BLACK SPECKS OR TRASH IN ELECTROLYTE |

| STEPS | KEY POINTS |
|---|---|
| | (1) WOOD SEPARATORS HAVE BEEN CHARRED<br>(2) RESULTS OF OVER CHARGE OR OVER HEATING<br>6. REPEAT OPERATION FOR ALL CELLS (3 OR 6) |
| 3. PERFORM HYDROMETER TEST | 1. SQUEEZE HYDROMETER BULB<br>2. INSERT RUBBER TIP IN BATTERY CELL OPENING<br>3. RELEASE BULB WITH HYDROMETER HELD VERTICALLY<br>4. ALLOW LIQUID TO FLOW INTO BARREL<br>5. THE FLOAT WILL RISE<br>6. HOLD TOP OF LIQUID IN HYDROMETER BARREL LEVEL WITH EYES<br>7. TAKE READING ON FLOAT AT BOTTOM OF LIQUID CURVE<br>8. IF HYDROMETER HAS THERMOMETER CHECK TEMPERATURE AND CONSULT CONVERSION TABLE TO ADD OR SUBTRACT POINTS FROM FLOAT READING<br>9. RECORD READING<br>10. REPEAT KEY POINTS 1 THROUGH 9 FOR ALL CELLS<br>NOTE: IF ANY ONE CELL IS IN EXCESS OF 15 POINTS LOWER THAN THE OTHER CELLS, IT COULD BE SHORTED OR SHORT ON ELECTROLYTE<br>a. SERVICE THE CELL<br>b. CHARGE BATTERY<br>c. IF CELL DOES NOT COME UP TO OTHERS OR COMES UP FOR SHORT TIME THE CELL IS DEFECTIVE. BATTERY MUST BE REPLACED<br>BE SURE TO CHECK TEMPERATURES FOR ALL READINGS ON HYDROMETER. IF THERMOMETER IS NOT ON HYDROMETER CHECK TEMPERATURE OF ELECTROLYTE WITH THERMOMETER. USE CONVERSION CHART TO FIND POINTS TO ADD TO OR SUBTRACT FROM THE HYDROMETER READING |
| 4. LOAD TEST BATTERY | 1. COMPLETE INFORMATION ABOUT THE |

| STEPS | KEY POINTS |
|---|---|
|  | BATTERY CONDITION AND CAPACITY CAN BE OBTAINED ONLY BY MAKING AN ELECTRICAL TEST<br>2. CAPACITY TEST IS NOT TO BE ATTEMPTED IF ELECTROLYTE SPECIFIC GRAVITY IS LOWER THAN 1.220<br>3. IF SPECIFIC GRAVITY IS BELOW 1.220 SLOW CHARGE BATTERY UNTIL FULLY CHARGED<br>4. USE BATTERY STARTER TESTER<br>a. ATTACH TESTER TO BATTERY ACCORDING TO MANUFACTURER'S SPECIFICATIONS<br>b. CARBON PILE LOAD TEST SWITCH TO BE IN OFF POSITION<br>c. CONNECT BOTH POSITIVE LEADS TO POSITIVE POST<br>d. CONNECT BOTH NEGATIVE LEADS TO NEGATIVE POST<br>5. CHECK BATTERY FOR AMP HOUR RATING<br>6. ADJUST CARBON PILE LOAD SWITCH TO PLACE A LOAD OF THREE TIMES THE AMPERE HOUR RATING ON THE BATTERY<br>7. MAINTAIN LOAD ON BATTERY FOR FIFTEEN SECONDS<br>a. 12 VOLT BATTERY MAINTAINS 9.5 VOLTS AFTER LOAD<br>b. 6 VOLT BATTERY MAINTAINS 4.8 VOLTS AFTER LOAD<br>8. IF BATTERY DOES NOT MAINTAIN 9.5 VOLTS OR 4.8 VOLTS AFTER TEST, PERFORM THREE MINUTE CHARGE TEST |
| 5. THREE MINUTE CHARGE TEST | 1. BATTERY TEMPERATURE TO BE ABOVE 60 DEGREES FAHRENHEIT<br>2. BATTERY CABLES ARE TO BE REMOVED FROM BATTERY<br>3. BATTERY CHARGER SWITCH IS TO BE IN OFF POSITION<br>4. PLUG BATTERY CHARGER INTO POWER SOURCE |

| STEPS | KEY POINTS |
|---|---|
| | 5. CONNECT POSITIVE LEAD OF BATTERY CHARGER TO POSITIVE POST OF BATTERY<br>6. CONNECT NEGATIVE LEAD OF BATTERY CHARGER TO NEGATIVE POST OF BATTERY<br>7. HOOK VOLT METER TO BATTERY POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE<br>8. SET BATTERY CHARGER TIMER<br>a. ON THREE MINUTES<br>b. TURN TIMER PAST THREE MINUTES<br>9. ADJUST CHARGING RATE<br>a. 40 AMPS FOR 12 VOLT BATTERY<br>b. 75 AMPS FOR 6 VOLT BATTERY<br>10. TURN ON BATTERY CHARGER AND ALLOW TO CHARGE UNTIL TIMER STOPS CHARGING RATE<br>11. CHARGER TO REMAIN ON<br>12. CHECK VOLT METER READING<br>a. READING IN EXCESS OF 15.5 VOLTS FOR 12 VOLT BATTERY OR 7.75 VOLTS FOR 6 VOLT BATTERY, REPLACE BATTERY<br>b. READING UNDER 15.5 OR 7.75, CHECK INDIVIDUAL CELLS<br>c. CELL VOLTAGES DIFFER MORE THAN .01 VOLT REPLACE BATTERY<br>d. CELL VOLTAGES DIFFER LESS THAN .01 VOLT, CHARGE BATTERY AND PLACE IN SERVICE |
| 6. LIGHT LOAD BATTERY TEST | 1. USE VOLTMETER<br>2. CRANK ENGINE FOR THREE SECONDS; ENGINE IS NOT TO START<br>3. TURN LIGHT ON<br>a. LOW BEAM<br>b. ALLOW TO BURN FOR ONE MINUTE<br>c. LEAVE LIGHTS ON<br>4. OIL IS TO RUN DOWN BOLT AND COVER NUT<br>5. WIPE OFF EXCESS OIL WITH RAG |
| 7. TEST BATTERY FOR OPERATION | 1. CLEAR ALL TOOLS AND MATERIALS FROM ENGINE COMPARTMENT |

| | |
|---|---|
| | 2. CLEAN HANDS<br>3. PLACE COVER OVER VEHICLE SEAT<br>4. CHECK SHOES, WIPE SOLES CLEAN BEFORE ENTERING VEHICLE<br>5. TURN ON IGNITION<br>6. START VEHICLE<br>7. IF STARTER DOES NOT TURN ENGINE OVER, OR TURNS SLOWLY:<br>a. CHECK BATTERY CONNECTIONS<br>b. MAY BE NECESSARY TO CHANGE BATTERY |
| 8. CLEAN WORK STATION | 1. AS HAS BEEN PERFORMED IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

STUDENTS TO BE FURNISHED WITH JOB AND TASK SHEETS.

STUDENTS TO PRACTICE TASK UNDER CLOSE SUPERVISION.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

PUT STUDENT ON THEIR OWN TO PERFORM TASK WITH THE SUPERVISION OF THE INSTRUCTOR

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

EMPHASIS PLACED ON SAFETY.
JEWELRY AND WORKING WITH ELECTRICITY.
WORKING WITH ACID.
WEARING OF FACE SHIELDS OR GOGGLES.
PICKING UP OF HEAVY OBJECTS.
REEMPHASIZE KEY POINTS OF LESSON.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 8
AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CHS. 13, 23

THE NEXT LESSON IS: VIII-C-2(S), "ISOLATE IGNITION PROBLEMS ON VEHICLE"

VIII-C-1(J)

# JOB SHEET
# ON
# ELECTRICAL SYSTEM

**JOB:** TEST STORAGE BATTERY

**MATERIAL:** BATTERY WATER, ELECTROLYTE, CLEAN RAGS

**TOOLS AND EQUIPMENT:** HYDROMETER, THERMOMETER, SPECIFIC GRAVITY CONVERSION CHART, BATTERY STARTER TESTER, BATTERY CHARGER

**GENERAL INSTRUCTIONS:** BATTERY EFFICIENCY DEPENDS UPON THE LEVEL OF CHARGE AND TEMPERATURE. CHARGE IS DEPENDENT ON THE MECHANICAL CONDITION OF THE BATTERY. PARTS OF THE BATTERY MUST BE IN A STATE OF GOOD REPAIR. BATTERIES ARE NOT TO BE CAPACITY TESTED IF THE SPECIFIC GRAVITY READING IS BELOW 1.220. IN THE EVENT THE SPECIFIC GRAVITY READING IS BELOW 1.220 IT WILL BE NECESSARY TO SLOW CHARGE THE BATTERY TO FULL CHARGE BEFORE THE CAPACITY TEST IS MADE. SAFETY AND CLEANLINESS ARE MUSTS WHEN WORKING WITH STORAGE BATTERIES.

WEAR GOGGLES OR FACE SHIELD WHEN WORKING WITH BATTERIES. REMOVE WATCHES AND RINGS BECAUSE BURNS CAN RESULT FROM ELECTRICAL SHORTS. ELECTROLYTE IS TO BE KEPT OFF PERSON AND CLOTHING. EXERCISE CAUTION NOT TO SHORT OUT BATTERY AS THE GASES GIVEN OFF BY THE ELECTROLYTE ARE EXPLOSIVE.

**PROCEDURE:**
VIII-C-1(TS), VISUALLY INSPECT BATTERY
VIII-C-1a(TS), TEST ELECTROLYTE

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR PROPER RESULTS AND FURTHER INSTRUCTION BEFORE PROCEEDING TO NEXT TASK.
VIII-C-1b(TS), LOAD TEST BATTERY
VIII-C-1c(TS), THREE MINUTE CHARGE TEST
VIII-C-1d(TS), LIGHT LOAD TEST BATTERY

# TASK SHEET

VIII-C-1(TS)

**TASK:** VISUALLY INSPECT BATTERY

**JOB:** TEST STORAGE BATTERY

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:**

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. BATTERY CASE | 1. CRACKS<br>a. CAN BE CRACKED FROM EXPANSION OF LARGE CRYSTAL SULPHATE ON PLATES<br>b. CAN BE CRACKED FROM FREEZING<br>c. CAN BE CRACKED FROM MECHANICAL DAMAGE<br>2. WEAR THROUGH FROM VIBRATION |
| 2. POST STRAP | 1. WORN THROUGH<br>2. PARTIALLY WORN THROUGH<br>3. MECHANICAL DAMAGE |
| 3. POST | 1. CORRODED<br>2. PITTED<br>3. LOOSE<br>4. DEFORMED<br>5. BROKEN |
| 4. CABLES | 1. INSULATION<br>2. DEFORMED<br>3. BROKEN<br>4. LOOSE<br>5. CORRODED |

TASK SHEET VIII-C-1a(TS)

TASK: TEST ELECTROLYTE

JOB: TEST STORAGE BATTERY

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HYDROMETER, CLEAN RAGS, THERMOMETER, ELECTROLYTE, TEMPERATURE CONVERSION TABLE. (HYDROMETER MAY COME EQUIPPED WITH CONVERSION TABLE AND THERMOMETER)

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. NOTE | 1. IF ANY ONE CELL IS IN EXCESS OF 15 POINTS LOWER THAN OTHER CELLS IT COULD BE SHORTED OR LOW ON ELECTROLYTE<br>a. BATTERY MUST BE SERVICED<br>b. BATTERY MUST BE CHARGED<br>c. IF CELL DOES NOT COME UP TO OTHERS OR COMES UP ONLY FOR A SHORT TIME AFTER SERVICE AND CHARGE, BATTERY MUST BE REPLACED<br>2. BE SURE TO CHECK TEMPERATURES FOR ALL READINGS ON HYDROMETER<br>3. IF THERMOMETER IS NOT ON HYDROMETER, USE NON-METALLIC GLASS THERMOMETER TO GET TEMPERATURE<br>4. USE ELECTROLYTE TEMPERATURE CONVERSION CHART TO DETERMINE NUMBER OF POINTS TO ADD TO OR SUBTRACT FROM THE HYDROMETER READING |
| 2. PREPARE BATTERY | 1. IF BATTERY HAS NOT BEEN CLEANED BRUSH OFF TOP OF BATTERY BEING SURE NO FOREIGN MATTER WILL FALL INTO CELLS<br>2. REMOVE CAPS FROM CELLS |
| 3. TAKE CELL READINGS | 1. EACH READING IS TO BE RECORDED<br>2. USE HYDROMETER<br>3. HOLD HYDROMETER VERTICAL WITH BULB UP |

| STEPS | KEY POINTS |
|---|---|
| | 4. SQUEEZE HYDROMETER BULB WITH ONE HAND FORCING AIR OUT |
| | 5. INSERT HYDROMETER TIP INTO ELECTROLYTE IN FIRST CELL ON POSITIVE POST SIDE OF BATTERY |
| | 6. RELEASE GRIP ON BULB |
| | a. DRAW ELECTROLYTE INTO HYDROMETER |
| | b. ALLOW TO STAND A FEW SECONDS |
| | c. SQUEEZE BULB AND FORCE ELECTROLYTE BACK INTO BATTERY |
| | d. REPEAT THIS PROCEDURE UNTIL THE THERMOMETER HAS REACHED BATTERY TEMPERATURE |
| | e. RECORD BATTERY TEMPERATURE |
| | 7. RELEASE GRIP ON BULB AND SLOWLY ALLOW ELECTROLYTE TO FLOW INTO HYDROMETER |
| | 8. WHEN THE FLOAT RISES STOP PULLING THE ELECTROLYTE INTO HYDROMETER, FLOAT MUST CLEAR BOTTOM OF HYDROMETER |
| | 9. CONTINUE TO HOLD THE BULB AT THIS POINT. DO NOT SQUEEZE OR RELAX GRIP |
| | 10. GENTLY TAP TIP ON SIDE OF THE CELL OPENING TO KNOCK OFF EXCESS ELECTROLYTE |
| | 11. RAISE HYDROMETER OUT OF CELL |
| | 12. PLACE FOLDED RAG UNDER TIP WITH OTHER HAND |
| | 13. RAISE (MONISCUS) CURVED TOP LEVEL OF LIQUID TO EYE LEVEL |
| | 14. HOLD HYDROMETER IN SUCH A MANNER AS TO ALLOW LIGHT TO SHOW THROUGH IN ORDER TO TAKE READING |
| | 15. TAKE READING AT BOTTOM OF CURVED LIQUID (MONISCUS) |
| | 16. LOWER TIP OF HYDROMETER BACK TO TOP OF CELL |
| | a. FROM WHICH ELECTROLYTE WAS REMOVED |
| | b. REMOVE RAG |

| STEPS | KEY POINTS |
|---|---|
| | c. INSERT TIP OF HYDROMETER IN CELL<br>17. GENTLY SQUEEZE BULB AND FORCE ELECTROLYTE BACK INTO CELL, MAKE SURE ALL ELECTROLYTE IS OUT OF HYDROMETER<br>18. RECORD READING WITH TEMPERATURE READING<br>19. REPEAT KEY POINTS 1 THROUGH 17 FOR ALL CELLS MOVING FROM POSITIVE SIDE OF BATTERY TO NEGATIVE SIDE OF BATTERY<br>20. PUT CAPS BACK ON BATTERY CELLS |
| 4. CLEAN HYDROMETER | 1. USE CLEAN WATER<br>2. DRAW WATER INTO HYDROMETER<br>3. SQUEEZE WATER OUT INTO DRAIN<br>4. REPEAT THIS PROCEDURE SEVERAL TIMES<br>5. RUN WATER OVER OUTSIDE OF HYDROMETER<br>6. DRY HYDROMETER ON OUTSIDE THOROUGHLY<br>7. STORE HYDROMETER |
| 5. DETERMINE BATTERY CONDITION | 1. COMBINE EACH CELL READING WITH TEMPERATURE<br>2. COMPARE EACH CELL READING AND TEMPERATURE WITH THE CONVERSION CHARTS<br>3. ADD TO OR SUBTRACT FROM EACH CELL READING POINTS AND SPECIFIED BY CONVERSION CHART<br>4. RECORD NEW READINGS<br>5. MAKE DECISION<br>a. TO SERVICE BATTERY<br>b. TO CHARGE BATTERY<br>c. BATTERY IS TO REMAIN IN SERVICE<br>d. BATTERY IS TO BE REPLACED |
| 6. CHECK POINT | CHECK WITH INSTRUCTOR FOR PROPER RESULTS OR FURTHER INSTRUCTIONS BEFORE PROCEEDING |
| 7. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-1b(TS)

**TASK:** LOAD TEST BATTERY

**JOB:** TEST STORAGE BATTERY

**TARADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HYDROMETER, BATTERY STARTER TESTER, BATTERY CHARGER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK BATTERY | 1. MECHANICALLY SOUND<br>2. ELECTROLYTE AT PROPER LEVEL IN BATTERY<br>3. USE HYDROMETER TO CHECK SPECIFIC GRAVITY<br>a. AS IN TASK VIII-A-2b(TS)<br>b. SPECIFIC GRAVITY IS NOT TO BE BELOW 1.220<br>c. IF SPECIFIC GRAVITY IS BELOW 1.220 SLOW CHARGE BATTERY UNTIL IT IS FULLY CHARGED |
| 2. CONNECT BATTERY STARTER TESTER | 1. CONNECT TESTER TO BATTERY ACCORDING TO MANUFACTURER'S SPECIFICATIONS<br>2. LOAD TEST SWITCH IS TO BE IN OFF POSITION<br>3. CONNECT TESTER LEADS TO BATTERY<br>a. CONNECT BOTH TESTER POSITIVE LEADS TO POSITIVE POST<br>b. CONNECT BOTH TESTER NEGATIVE LEADS TO NEGATIVE POST<br>4. CHECK LEGEND ON BATTERY OR MANUFACTURER'S MANUAL FOR BATTERY AMP HOUR RATING<br>5. MULTIPLY THE BATTERY AMP HOUR RATING BY THREE |
| 3. TEST BATTERY | 1. TURN ON (CARBON PILE SWITCH) LOAD SWITCH<br>2. ADJUST THE LOAD SWITCH TO NUMBER FOUND BY MULTIPLYING THE BATTERY AMP HOUR RATING BY THREE |

| STEPS | KEY POINTS |
|---|---|
| | 3. MAINTAIN LOAD ON BATTERY FOR 15 SECONDS<br>a. 12 VOLT BATTERY IS TO MAINTAIN 9.5 VOLTS AFTER 15 SECOND LOAD<br>b. 6 VOLT BATTERY IS TO MAINTAIN 4.8 VOLTS AFTER 15 SECOND LOAD<br>4. TURN OFF TESTER AFTER 15 SECONDS<br>5. IF BATTERY DOES NOT MAINTAIN 9.5 VOLTS FOR 12 VOLT BATTERIES OR 4.8 VOLTS FOR 6 VOLT BATTERIES AFTER LOAD TEST, PERFORM 3 MINUTE TEST AS IN TASK VIII-A-2d(TS) |
| 4. DISCONNECT TESTER | 1. NEGATIVE LEADS FIRST<br>2. POSITIVE LEADS LAST<br>3. NEATLY LOOP TESTER LEADS OVER BRACKETS ON TESTER<br>4. STORE TESTER |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-1c(TS)

**TASK:** THREE MINUTE CHARGE TEST

**JOB:** TEST STORAGE BATTERY

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** VOLTMETER, BATTERY CHARGER, BATTERY TERMINAL TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK BATTERY TEMPERATURE | 1. REMOVE BATTERY CABLES, NEGATIVE LEAD FIRST<br>2. USE GLASS TYPE THERMOMETER OR HYDROMETER AS IN TASK VIII-A-2b(TS)<br>3. BATTERY TEMPERATURE MUST BE ABOVE 60 DEGREES F. |
| 2. CONNECT BATTERY CHARGER | 1. CHARGER SWITCH IS TO BE IN OFF POSITION<br>2. CONNECT CHARGER LEADS TO BATTERY<br>a. POSITIVE TO POSITIVE POST FIRST<br>b. NEGATIVE TO NEGATIVE POST SECOND<br>3. PLUG CHARGER INTO POWER SOURCE |
| 3. CONNECT VOLTMETER | 1. TO BATTERY<br>2. POSITIVE LEAD TO POSITIVE POST FIRST<br>3. NEGATIVE LEAD TO NEGATIVE POST LAST |
| 4. CHARGE BATTERY | 1. SET CHARGER TIMER<br>a. 3 MINUTES<br>b. TURN TIMER PAST 3 MINUTES AND CAREFULLY BACK TO 3 MINUTES<br>2. ADJUST CHARGER CHARGING RATE<br>a. 40 AMPS FOR 12 VOLT BATTERY<br>b. 75 AMPS FOR 6 VOLT BATTERY<br>3. TURN ON CHARGER AND ALLOW TO CHARGE UNTIL TIMER STOPS CHARGING RATE |
| 5. CHECK VOLTMETER READING | 1. CHARGER TO REMAIN ON<br>2. READING IN EXCESS OF 15.5 VOLTS FOR 12 VOLT BATTERY OR 7.75 VOLTS |

| STEPS | KEY POINTS |
|---|---|
| | FOR 6 VOLT BATTERY, REPLACE BATTERY<br>3. READINGS OF UNDER 15.5 OR 7.75 INDIVIDUAL CELLS MUST BE CHECKED<br>4. CELL VOLTAGE DIFFERENCES OF MORE THAN .01 VOLT, BATTERY IS TO BE REPLACED<br>5. CELL VOLTAGE DIFFERENCE OF LESS THAN .01 VOLT, CHARGE BATTERY AND PLACE IN SERVICE |
| 6. DISCONNECT EQUIPMENT | 1. TURN OFF CHARGER<br>2. VOLT METER NEGATIVE LEAD FIRST AND THEN POSITIVE LEAD<br>3. ROLL UP THE VOLT METER LEADS AND PLACE VOLT METER IN STORAGE<br>4. DISCONNECT CHARGER NEGATIVE LEAD FIRST AND THEN POSITIVE LEAD<br>5. ROLL UP LEADS AND HANG ON CHARGER BRACKETS<br>6. STORE BATTERY CHARGER<br>7. CONNECT BATTERY LEADS POSITIVE FIRST AND THEN NEGATIVE |
| 7. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-1d(TS)

TASK: LIGHT LOAD TEST BATTERY
JOB: TEST STORAGE BATTERY
TRADE: AUTOMECHANICS
TOOLS AND MATERIALS: VOLTMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE BATTERY FOR TEST | 1. CRANK ENGINE FOR 3 SECONDS<br>2. ENGINE IS NOT TO START<br>3. TURN LIGHTS ON<br>a. ON LOW BEAM<br>b. ALLOW LIGHTS TO BURN 1 MINUTE<br>c. LEAVE LIGHTS ON |
| 2. MAKE BATTERY TEST | 1. USE VOLTMETER<br>2. PLACE VOLTMETER PROBES ON BATTERY POSTS<br>3. BATTERY VOLTAGE READING IS TO BE 11.70 OR BETTER<br>4. LOW READING<br>a. TURN LIGHTS OFF<br>b. REMOVE BATTERY CABLES<br>c. SLOW CHARGE BATTERY UNTIL FULLY CHARGED<br>d. DISCONNECT BATTERY CHARGER<br>e. REPLACE BATTERY CABLES<br>f. REPEAT STEP 1 AND KEY POINTS 1, 2, 3, OF STEP 2 |
| 3. TEST CELLS | 1. BATTERIES WITH EXPOSED CELL STRAPS<br>2. STEP ONE APPLIES HERE<br>3. PROBE EACH CELL WITH VOLTMETER<br>a. POSITIVE POST TO END OF STRAP IN SAME CELL<br>b. END OF STRAP TOWARDS POSITIVE POST IN EACH CELL IS POSITIVE SIDE<br>4. EACH CELL IS TO HAVE A VOLTAGE READING OF 1.95 OR MORE |

| STEPS | KEY POINTS |
|---|---|
| | 5. IF THERE IS NO MORE THAN .05 VOLT DEVIATION BETWEEN BATTERY CELLS, BATTERY IS GOOD |
| | 6. IF THE CELL DEVIATION IS MORE THAN .05 VOLT THE PROBABLE INDICATION IS THAT THE BATTERY IS DEFECTIVE |
| | 7. LOW CELL READINGS ALL ACROSS THE BATTERY NEEDS CHARGING AND RETESTING |
| 4. CLEAN WORK STATION | AS IN PRECEDING TASKS |

INSTRUCTOR'S PLAN VIII-C-6(I)

INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | IGNITION AND COMBUSTION |
| AIM: | THE STUDENT WILL BE ABLE TO IDENTIFY THE FACTORS RELATED TO INTERNAL COMBUSTION AND COMPARE IGNITION TIMING WITH ENGINE EFFICIENCY. |
| TEACHING AIDS: | CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMECHANICS, GLENN, PP. 333-341<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 200-204<br>AUTO SERVICE AND REPAIR, STOCKEL, PP. 23-10 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON. |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WE WILL SOON BE LEARNING ABOUT PRIMARY CIRCUITS, SECONDARY CIRCUITS, COILS, DISTRIBUTORS, AND SPARK PLUGS. WE WILL SEE THAT THE PRIMARY FUNCTION OF ALL OF THESE IS TO DELIVER A SPARK TO THE PROPER ENGINE CYLINDER AT THE CORRECT TIME. WHAT HAPPENS WHEN THAT SPARK REACHES THE CYLINDER IS WHAT WE WILL LEARN ABOUT TODAY.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION | |
| 1. FOUR STROKE CYCLE | 1. AIR-FUEL SUCKED IN BY PISTON DOWN STROKE |
| | 2. PISTON COMES UP COMPRESSING MIXTURE |
| | 3. SPARK IGNITES MIXTURE WHEN PISTON NEAR TOP DEAD CENTER |
| | 4. EXPANDING GASES FORCE PISTON DOWN IN POWER STROKE |
| | 5. PISTON COMES UP IN EXHAUST STROKE |
| | 6. THE PISTON STARTS DOWN RENEWING CYCLE |
| 2. FUEL-AIR MIXTURE | 1. AIR-FUEL RATIO 10.5 : 1 TO 15 : 1 |

2. COMBUSTION EFFICIENCY 60% TO 100%
   a. TESTED WITH COMBUSTION ANALYZER
   b. MANY FACTORS CAUSE VARIATION
3. REQUIRES APPROXIMATELY .003 SECOND TO BURN
4. AIR COMPOSED OF 20% OXYGEN
5. GASOLINE IS MOSTLY COMPOSED OF HYDROGEN AND CARBON (HYDROCARBON)
   a. VARIES IN ABILITY TO VAPORIZE (VOLATILITY)
   b. VARIES IN OCTANE RATING
      (1) LOW OCTANE KNOCKS EASILY
      (2) KIGH OCTANE RESISTANT TO KNOCKING
   c. FUEL BLENDED FOR DIFFERENT CLIMATES AND ENGINES

b. COMBUSTION
   1. NORMAL

1. FUEL-AIR UNIFORMLY MIXED
2. THE PISTON COMES UP COMPRESSING GASES
3. SPARK IGNITES MIXTURE
4. FUEL CHARGE BURNS EVENLY ACROSS COMPRESSION CHAMBER
5. HEAT CHANGES HYDROCARBONS AND OXYGEN TO WATER VAPOR AND CARBON DIOXIDE
6. ENERGY GIVEN UP BY THE EXCHANGE DRIVES PISTON DOWN SMOOTHLY IN POWER STROKE
7. WATER VAPOR AND CARBON DIOXIDE EXIT THROUGH EXHAUST SYSTEM

CAUTION: CARBON MONOXIDE IS ALSO GIVEN OFF BY EXHAUST SYSTEMS. STUDENT SHOULD BE WARNED ABOUT THE LEAKY EXHAUST SYSTEMS: RUNNING ENGINES IN ENCLOSED PLACES

   2. DETONATION

1. CAUSES OF DETONATION
   a. HEAT OF COMPRESSION REACHES CRITICAL LEVEL

- b. RADIANT HEAT FROM COMBUSTION PROCESS
- c. GASOLINE TOO VOLATILE
- d. "HOT SPOTS" IN CYLINDER

2. LAST PART OF FUEL MIXTURE EXPLODES VIOLENTLY CAUSING SUDDEN PRESSURE ON PISTON
    - a. COMPARABLE TO HAMMER BLOW ON PISTON
    - b. MAY CAUSE HARD KNOCKING NOISE
    - c. CAUSES RAPID WEAR AND BREAKAGE
    - d. FUEL ENERGY WASTED

3. SERVICE RELATED PROBLEMS

1. SURFACE IGNITION AND PREIGNITION RESULT FROM IMPROPER ENGINE SERVICING
    - a. INSTALLING TOO HOT PLUGS
    - b. INCORRECT FUELS OR LUBRICATING OILS CAUSING ENGINE DEPOSITS
2. "HOT SPOTS" IN CHAMBER CAUSED BY:
    - a. HOT EXHAUST VALVE
    - b. SPARK PLUG TIP OVERHEATED
    - c. CARBON DEPOSIT

C. TIMING REQUIREMENTS

1. ECONOMY

1. COMBUSTION COMPLETED 10 TO 20 DEGREES PAST TOP DEAD CENTER
2. COMBUSTION EARLY ALLOWS TOTAL FUEL BURN

2. COMBUSTION RATE

1. AFFECTED BY LOAD AND SPEED CONDITIONS
2. SLOWER COMBUSTION REQUIRES:
    - a. MORE ADVANCED TIMING
    - b. LESS VOLATILE FUEL MIXTURE
    - c. HIGH OCTANE FUEL
    - d. LARGER CYLINDER BORES
    - e. LOW LOAD AT LOW SPEED
    - f. FULL LOAD AT HIGH SPEED
3. FASTER RATE OF COMBUSTION REQUIRES:
    - a. MORE RETARDED TIMING
    - b. GOOD AIR-FUEL MIXTURE
    - c. HOT ENGINE TEMPERATURE

d. HIGH COMPRESSION RATIO
e. FULL LOAD AT LOW SPEED

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT HAPPENS IN EACH STROKE OF A FOUR (4) STROKE CYCLE ENGINE ?

ANSWER: A. PISTON GOES DOWN SUCKING IN AIR AND FUEL.
B. PISTON COMES UP COMPRESSING MIXTURE.
C. FUEL IGNITES AND EXPANDING GASES PUSH PISTON DOWN IN POWER STROKE.
D. PISTON COMES UP IN EXHAUST STROKE PUSHING OUT GASES.

2. GASOLINE IS MADE UP OF WHAT MAIN ELEMENTS?

ANSWER: HYDROGEN AND CARBON (HYDROCARBON)

3. WHAT ARE THESE ELEMENTS CONVERTED TO IN COMBUSTION?

ANSWER: WATER VAPOR AND CARBON DIOXIDE

4. WHY NOT RUN AN ENGINE IN A CLOSED GARAGE?

ANSWER: CARBON MONOXIDE, A VERY POISONOUS GAS, BUILDS UP TO DEADLY PROPORTIONS IN A FEW MINUTES.

5. WHY IS TIMING IMPORTANT IN FUEL ECONOMY?

ANSWER: IGNITION SHOULD ALLOW ENOUGH TIME FOR COMPLETE BURNING OF THE FUEL CHARGE.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

TRUE - FALSE TEST

1. FUEL VOLATILITY REFERS TO ITS EASE OF VAPORIZATION. T
2. FUELS ARE BLENDED FOR CLIMATES AND ENGINES. T
3. DETONATION REFERS TO SMOOTH EVEN COMBUSTION. F
4. AIR IS COMPOSED OF 60% OXYGEN. F
5. OCTANE RATING REFERS TO KNOCK RESISTANCE. T
6. HIGH COMPRESSION ENGINES ARE MORE PRONE TO KNOCK. T
7. A HOT ENGINE ECONOMIZES FUEL BETTER. T

## IV. VERIFICATION (CON'T.)

8. GASOLINE IS COMPOSED OF HYDROCARBONS. T

9. CARBON DIOXIDE IS A HIGHLY POISONOUS GAS. F

10. USING THE WRONG OIL IN AN ENGINE CAN CAUSE DETONATION AND PREIGNITION. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS)

1. GASOLINES ARE BLENDED FOR KNOCK RESISTANCE AND VOLATILITY FOR DIFFERENT CLIMATES AND ENGINES.
2. UNDER IDEAL CONDITIONS, COMBUSTION OCCURS AT THE RIGHT TIME, BURNS EVENLY ACROSS THE COMPRESSION CHAMBER, AND DRIVES THE PISTON DOWN SMOOTHLY ON THE POWER STROKE.
3. DETONATION REFERS TO PART OF THE FUEL CHARGE EXPLODING VIOLENTLY AND CAUSING DAMAGE.
4. IGNITION TIMING REQUIREMENTS VARY WITH LOAD AND SPEED CONDITIONS, FUEL, AND ENGINES.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CH. 15 AND 25

THE NEXT LESSON IS: VIII-C-7(I), "ISOLATING IGNITION PROBLEMS ON THE VEHICLE"

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

VIII-C-7(I)

| | |
|---|---|
| SUBJECT: | ISOLATING IGNITION PROBLEMS ON THE VEHICLE |
| AIM: | THE STUDENT WILL BE ABLE TO MAKE JUDGMENTS AND DECISIONS AS TO TESTS AND TESTING PROCEDURES NEEDED TO ISOLATE VEHICLE IGNITION PROBLEMS |
| TEACHING AIDS: | MANUFACTURER'S TEST EQUIPMENT MANUALS, REFER TO COMPONENT LESSONS AND TRANSPARENCIES I ED II 7T, FIG. 342 |
| MATERIALS: | |
| REFERENCES: | AUTO SERVICE AND REPAIR, CH. 23-1 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENTS MUST HAVE SATISFACTORILY COMPLETED THE PREVIOUS REPAIR PROCEDURES FOR THE IGNITION SYSTEM |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE IGNITION SYSTEM SHARES THE RESPONSIBILITY FOR MAKING AN ENGINE RUN WITH BOTH CARBURETION AND COMPRESSION.

IN ORDER TO DETERMINE VEHICLE IGNITION SYSTEM PROBLEMS, OR, FOR THAT MATTER, ANY SYSTEM, THE SYSTEM MUST BE CONSIDERED AND STUDIED FROM FOUR VIEWPOINTS: ITS COMPONENT PARTS, HOW THESE COMPONENT PARTS SHOULD PERFORM, WHAT CAN GO WRONG WITH THESE COMPONENTS, AND HOW THESE COMPONENTS ARE CHECKED AND TESTED.

AT TIMES IT BECOMES NECESSARY TO PERFORM IGNITION SYSTEM TESTS ON THE VEHICLE. THIS WILL:

a. SAVE TIME.
b. SAVE CUSTOMER MONEY.
c. INSURE THAT THE SERVICE AND REPAIR CAN BE DONE IN AN EFFECTIVE AND EFFICIENT MANNER.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. IGNITION SYSTEM CIRCUITS | 1. PRIMARY, LOW VOLTAGE, CIRCUIT<br>2. SECONDARY, HIGH VOLTAGE, CIRCUIT |
| 1. PRIMARY CIRCUITS COMPONENTS | 1. BATTERY<br>2. IGNITION SWITCH |

3. PRIMARY CIRCUIT RESISTANCE WIRE
4. IGNITION COIL PRIMARY WINDINGS
5. BREAKER POINTS
6. CONDENSER

2. SECONDARY CIRCUIT COMPONENTS

1. IGNITION COIL SECONDARY WINDINGS
2. DISTRIBUTOR ROTOR
3. DISTRIBUTOR CAP
4. HIGH TENSION (SPARK PLUG) WIRES
5. SPARK PLUGS

B. PRIMARY CURRENT

1. BREAKER POINTS CLOSED
2. CURRENT FLOWS FROM BATTERY THROUGH IGNITION SWITCH TO COIL PRIMARY WINDINGS
3. CURRENT THEN FLOWS TO GROUND THROUGH CLOSED POINTS
4. BREAKER POINTS OPEN AND A MAGNETIC FIELD BUILDS UP IN COIL PRIMARY WINDING AND MOVES THROUGH COIL SECONDARY WINDINGS

C. SECONDARY VOLTAGE

1. HIGH VOLTAGE IS PRODUCED FROM PRIMARY MAGNETIC FIELD MOVING INTO SECONDARY COIL WINDINGS
2. HIGH VOLTAGE IS PRODUCED EACH TIME POINTS OPEN
3. HIGH VOLTAGE MOVES FROM COIL THROUGH HIGH TENSION LEAD TO DISTRIBUTOR CAP
4. ROTOR DISTRIBUTES HIGH VOLTAGE TO SPARK PLUG TERMINALS IN CAP
5. PROCESS IS REPEATED FOR EACH POWER STROKE OF ENGINE

D. IGNITION SYSTEM TROUBLE CAUSES

1. FAILURE IN PRIMARY OR SECONDARY CIRCUIT
2. INCORRECT IGNITION TIMING
3. INCORRECT DISTRIBUTOR ADVANCE

E. CIRCUIT FAILURE

1. SHORTS
2. CORRODED OR DIRTY TERMINALS
3. LOOSE CONNECTIONS
4. DEFECTIVE WIRE INSULATION
5. CRACKED DISTRIBUTOR CAP OR ROTOR
6. DEFECTIVE POINTS OR CONDENSER
7. FOULED SPARK PLUGS
8. IMPROPER DWELL ANGLE

| | |
|---|---|
| F. ENGINE STARTING OR OPERATING TROUBLE | 1. START ENGINE AND VERIFY TROUBLE<br>2. IF ENGINE WILL NOT START<br>a. BE SURE GASOLINE IS IN TANK<br>b. BE SURE GASOLINE IS REACHING CARBURETOR<br>3. LOCATE IGNITION SYSTEM PROBLEM<br>a. WITH OSCILLOSCOPE<br>b. BY SPARK INTENSITY TEST |

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III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS, OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. OTHER THAN IGNITION WHAT OTHER TWO THINGS ARE RESPONSIBLE FOR MAKING AN ENGINE RUN?

A. CARBURETION B. COMPRESSION

2. WHEN DETERMINING IGNITION SYSTEM PROBLEMS WHAT FOUR ITEMS MUST BE TAKEN INTO CONSIDERATION?

A. COMPONENT PARTS
B. HOW THESE COMPONENT PARTS SHOULD PERFORM
C. WHAT CAN GO WRONG WITH THESE COMPONENTS
D. HOW THESE COMPONENTS ARE CHECKED AND TESTED

3. WHAT ARE THE TWO IGNITION SYSTEM CIRCUITS?

A. PRIMARY B. SECONDARY

4. WHAT IS THE FLOW OF CURRENT THROUGH THE PRIMARY CIRCUIT?

THE BREAKER POINTS ARE CLOSED, CURRENT THEN FLOWS FROM THE BATTERY THROUGH THE IGNITION SWITCH TO THE COIL PRIMARY WINDINGS AND THROUGH THE CLOSED POINTS TO GROUND.

5. HOW DO THE CONTACT POINTS AFFECT SECONDARY VOLTAGE?

AS THE POINTS OPEN, HIGH VOLTAGE IS PRODUCED IN THE COIL SECONDARY WINDING BY THE PRIMARY MAGNETIC FIELD MOVING INTO THE SECONDARY WINDINGS.

6. WHAT ARE THREE IGNITION SYSTEM TROUBLE CAUSES?

A. PRIMARY OR SECONDARY CIRCUIT FAILURE
B. INCORRECT IGNITION TIMING
C. INCORRECT DISTRIBUTOR ADVANCE

7. WHAT ARE SOME CIRCUIT FAILURES?

A. SHORTS

B. CORRODED OR DIRTY TERMINALS
C. LOOSE CONNECTIONS
D. DEFECTIVE WIRE INSULATION
E. CRACKED DISTRIBUTOR CAP OR ROTOR
F. DEFECTIVE POINTS OR CONDENSER
G. FOULED SPARK PLUGS
H. IMPROPER DWELL ANGLE

8. WHAT TWO TESTS CAN BE USED TO LOCATE IGNITION SYSTEM PROBLEMS?

A. USE OSCILLOSCOPE
B. PERFORM SPARK INTENSITY TEST

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENT'S COMPREHENSION OF MATERIALS PRESENTED.)

| | | |
|---|---|---|
| 1. | AN IGNITION SYSTEM SHARES THE RESPONSIBILITY FOR MAKING AN ENGINE RUN WITH BOTH CARBURETION AND COMPRESSION. | T |
| 2. | IN ORDER TO DETERMINE IGNITION SYSTEM PROBLEMS THE MECHANIC MUST STUDY THE SYSTEM COMPONENTS AND HOW THESE COMPONENTS SHOULD PERFORM. | T |
| 3. | THE SECONDARY IGNITION SYSTEM CIRCUIT IS THE LOW VOLTAGE CIRCUIT. | F |
| 4. | THE PRIMARY IGNITION SYSTEM CIRCUIT IS THE HIGH VOLTAGE CIRCUIT. | F |
| 5 | ONE OF THE COMPONENT PARTS OF THE PRIMARY IGNITION CIRCUIT IS THE HIGH TENSION WIRES. | F |
| 6 | WITHIN THE SECONDARY IGNITION CIRCUIT THE CONDENSER IS FOUND. | F |
| 7. | WITH THE BREAKER POINTS CLOSED, CURRENT FLOWS FROM THE BATTERY THROUGH THE IGNITION SWITCH TO THE COIL PRIMARY WINDING. | T |
| 8. | HIGH TENSION VOLTAGE IS CREATED EACH TIME THE BREAKER POINTS OPEN. | T |
| 9. | HIGH TENSION VOLTAGE IS TRANSFERRED TO THE SPARK PLUG TERMINALS OF THE DISTRIBUTOR CAP BY THE BREAKER POINTS WIPER ARM. | F |
| 10. | IGNITION TIMING IS ONE MAJOR CAUSE OF IGNITION SYSTEM TROUBLE. | T |

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

I. IGNITION SYSTEM CIRCUIT
    A. PRIMARY - LOW VOLTAGE
    B. SECONDARY - HIGH VOLTAGE

II. PRIMARY CIRCUIT COMPONENTS
    A. BATTERY
    B. IGNITION SWITCH
    C. PRIMARY CIRCUIT RESISTANCE WIRE
    D. PRIMARY WINDINGS OF COIL
    E. POINTS
    F. CONDENSER

III. SECONDARY CIRCUIT COMPONENTS
    A. SECONDARY WINDINGS OF COIL
    B. ROTOR
    C. PLUG WIRES
    D. SPARK PLUGS

IV. PRIMARY CURRENT
    A. BREAKER POINTS CLOSED
    B. BATTERY CURRENT THROUGH A SWITCH TO COIL PRIMARY WINDINGS
    C. TO GROUND THROUGH CLOSED POINTS

V. SECONDARY VOLTAGE
    A. POINTS OPEN
    B. PRIMARY MAGNETIC FIELD TRANSFERRED TO SECONDARY WINDINGS
    C. FLOWS THROUGH COIL HIGH TENSION LEAD TO DISTRIBUTOR CAP
    D. FROM DISTRIBUTOR CAP TO ROTOR
    E. FROM ROTOR TO PLUG TERMINALS IN DISTRIBUTOR CAP
    F. FROM TERMINALS TO PLUG WIRES
    G. PLUG WIRES TO PLUGS

VI. CAUSE OF IGNITION TROUBLES
    A. PRIMARY OR SECONDARY CIRCUIT FAILURE
    B. IGNITION TIMING OFF
    C. DISTRIBUTOR ADVANCE OFF

VII. CIRCUIT FAILURE
    A. SHORTS
    B. CORRODED OR DIRTY TERMINALS
    C. CONNECTION LOOSE
    D. DISTRIBUTOR CAP OR ROTOR CRACKED OR DEFECTIVE
    E. POINTS OR CONDENSER BAD
    F. BAD PLUGS OR FOULED
    G. DWELL ANGLE OFF

VIII. ENGINE STARTING OR OPERATING TROUBLES
  A. START ENGINE TO VERIFY TROUBLE
  B. ENGINE WILL NOT START
    1. CHECK FOR GASOLINE IN TANK
    2. CHECK FOR GASOLINE GETTING TO CARBURETOR
  C. LOCATE PROBLEM
    1. USE SCOPE
    2. PERFORM SPARK INTENSITY TEST

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SUGGESTED READING FOR THE STUDENT:

INFORMATION SHEET, VIII-C-3(IS), "ISOLATING IGNITION PROBLEMS ON THE VEHICLE".

THE NEXT LESSON IS: VIII-B-2(I), "SPARK PLUGS"

THE NEXT LESSON IS THIS SERIES IS: VIII-C-9(I) "SECONDARY WIRING"

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VIII-C-2(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | ISOLATE IGNITION PROBLEMS ON THE VEHICLE |
| AIM: | THE STUDENT WILL BE ABLE TO DIAGNOSE AUTOMOTIVE IGNITION PROBLEMS ON THE VEHICLE: USING TOOLS, EQUIPMENT, AND SPECIFICATIONS CALLED FOR IN THE JOB. |
| TOOLS AND EQUIPMENT: | FENDER COVERS, SEAT COVER, DROP LIGHT, TIMING LIGHT, TACH AND DWELL METER, VOLTMETER, AMMETER, HAND TOOLS, AUXILIARY STARTER SWITCH |
| MATERIALS: | HEAT RESISTANT LUBRICANT, CLEAN RAGS |
| TEACHING AIDS: | JOB AND TASK SHEETS VIII-C-2 |
| REFERENCES: | INFORMATION SHEET VIII-C-3(IS) "ISOLATING IGNITION PROBLEMS ON THE VEHICLE" |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS. THE STUDENT MUST HAVE SATISFACTORILY PERFORMED THE PRECEDING TASKS IN MINOR BLOCK VIII-A |
| CHECKING STANDARDS: | 1. TOOL AND EQUIPMENT SELECTION<br>2. TEST HOOKUPS<br>3. VEHICLE PREPARATION<br>4. SAFE WORKING HABITS<br>5. CRAFTSMANLIKE PERFORMANCE OF TOOLS<br>6. ATTITUDE OF APPRECIATION FOR TOOLS, EQUIPMENT, SUPPLIES, AND CUSTOMER'S VEHICLE<br>7. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR<br>8. DIAGNOSIS OF IGNITION PROBLEMS |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN PERFORMING TESTS, ADJUSTMENTS, OR REPAIRS ON AUTOMOBILE IGNITION SYSTEMS IT IS ESSENTIAL TO FOLLOW THE PROCEDURES AND SPECIFICATIONS OF THE MANUFACTURER. TOO, IT IS NECESSARY TO REFER TO THE TEST EQUIPMENT MANUFACTURER'S HANDBOOK FOR HOOKUPS FOR SPECIFIC TESTS.

IGNITION PROBLEMS ARE CAUSED BY A BREAKDOWN IN THE PRIMARY, SECONDARY, OR PERHAPS BOTH CIRCUITS. MECHANICAL PROBLEMS CAN BE INCORRECT TIMING OR INCORRECT DISTRIBUTOR ADVANCE.

## I. PREPARATION (CON'T.)

CIRCUIT FAILURES CAN BE SHORTS, CORRODED OR DIRTY TERMINALS, LOOSE CONNECTIONS, DEFECTIVE INSULATION, CRACKED DISTRIBUTOR CAP OR ROTOR, DEFECTIVE BREAKER POINTS, FOULED SPARK PLUGS, OR IMPROPER ANGLE OF DWELL.

THIS LESSON WILL PRESENT THE SPARK INTENSITY TESTING PROCEDURE FOR LOCATING IGNITION SYSTEM PROBLEMS.

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION AND PREPARE VEHICLE | AS IN PRECEEDING TASKS |
| 2. ISOLATE PROBLEM CIRCUIT | 1. CONNECT AUXILIARY STARTER SWITCH INTO STARTING CIRCUIT |
| | 2. REMOVE COIL SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP<br>NOTE: THIS TEST IS NOT TO BE PERFORMED ON VEHICLES EQUIPPED WITH ELECTRONIC IGNITION |
| | 3. USE HIGH TENSION IGNITION PLIERS ON COIL SECONDARY WIRE |
| | 4. HOLD END OF COIL SECONDARY WIRE APPROXIMATELY 3/16 INCH FROM CYLINDER HEAD OR ANY GOOD GROUND |
| | 5. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH |
| | 6. IF THE SPARK IS GOOD AND STRONG THE TROUBLE IS IN THE PRIMARY CIRCUIT |
| | 7. IF THERE IS NO SPARK OR A WEAK SPARK, TROUBLE IS IN THE SECONDARY CIRCUIT, COIL TO DISTRIBUTOR HIGH TENSION LEAD, OR THE COIL |
| 3. PRIMARY CIRCUIT TEST | |
| A. BATTERY TO COIL VOLTMETER TEST | 1. REMOVE THE PRIMARY LEAD FROM THE COIL, SWITCH SIDE |
| | 2. POSITION A BARE METAL EXTENSION BETWEEN COIL PRIMARY TERMINAL AND PRIMARY LEAD TERMINAL |

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3. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION ON COIL PRIMARY TERMINAL
4. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
5. REMOVE PRIMARY LEAD FROM COIL, DISTRIBUTOR SIDE
6. INSTALL JUMPER ON PRIMARY TERMINAL, DISTRIBUTOR SIDE
7. GROUND OPPOSITE END OF JUMPER ON DISTRIBUTOR HOUSING
8. TURN OFF ALL LIGHTS AND ACCESSORIES
9. TURN THE IGNITION SWITCH TO ON POSITION
10. OBSERVE VOLTMETER READING
11. IF READING ON VOLTMETER IS BETWEEN 4.5 AND 6.9 VOLTS, PRIMARY CIRCUIT FROM BATTERY TO COIL IS SATISFACTORY
12. IF READING ON VOLTMETER IS MORE THAN 6.9 VOLTS, CHECK:
    a. BATTERY POSTS AND CABLES FOR CORROSION OR LOOSE CONNECTIONS
    b. PRIMARY WIRING
        (1) DAMAGED OR WORN INSULATION
        (2) BROKEN STRANDS OF WIRE
        (3) LOOSE OR CORRODED CONNECTIONS
13. IF THE READING ON VOLTMETER IS LESS THAN 4.5 VOLTS:
    a. REPLACE IGNITION RESISTANCE WIRE
    b. CHECK STARTER RELAY TO IGNITION SWITCH FOR DAMAGE

B. STARTING IGNITION CIRCUIT VOLTMETER TEST

1. INSTALL AUXILIARY STARTER SWITCH IN STARTING CIRCUIT
2. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE
3. CONNECT A BARE METAL EXTENSION BETWEEN COIL PRIMARY SWITCH TERMINAL AND SWITCH LEAD

4. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION AT COIL SWITCH, PRIMARY SIDE
5. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
6. REMOVE COIL TO DISTRIBUTOR SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP
7. GROUND THE SECONDARY WIRE JUST REMOVED FROM DISTRIBUTOR
8. TURN IGNITION SWITCH TO OFF POSITION
9. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH
10. OBSERVE VOLTMETER FOR VOLTAGE DROP
11. IF VOLTAGE DROP IS 0.4 VOLT OR LESS, STARTING IGNITION CIRCUIT IS SATISFACTORY
12. IF VOLTAGE DROP IS GREATER THAN 0.4 VOLT:
    a. CLEAN AND TIGHTEN TERMINALS IN CIRCUIT
    b. OR REPLACE WIRING AS NEEDED

C. IGNITION SWITCH VOLTMETER TEST

1. CHECK VEHICLE WIRING DIAGRAM, LOCATED DISCONNECT FOR IGNITION
2. SEPARATE WIRING HARNESS SWITCH LEAD FROM IGNITION SWITCH
3. FABRICATE JUMPER LEAD
    a. USE WIRE SIMILAR TO IGNITION SWITCH
    b. DETERMINE LENGTH OF WIRE NEEDED
    c. PEEL OFF ½ INCH OF INSULATION IN CENTER OF WIRE
    d. REMOVE ¼ INCH OF INSULATION FROM EACH END OF WIRE
    e. INSTALL A FEMALE CONNECTOR ON ONE END OF WIRE
    f. INSTALL A MALE CONNECTOR ON OPPOSITE END OF WIRE

4. CONNECT JUMPER LEAD BETWEEN IGNITION SWITCH AND SWITCH PRIMARY LEAD IN WIRING HARNESS
5. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE MIDDLE SECTION OF JUMPER LEAD
6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE SIDE OF BATTERY
7. INSTALL JUMPER WIRE BETWEEN DISTRIBUTOR PRIMARY TERMINAL ON COIL AND A GOOD GROUND ON THE DISTRIBUTOR BODY
8. TURN OFF ALL ACCESSORIES AND LIGHTS
9. TURN THE IGNITION SWITCH TO ON POSITION
10. IF VOLTMETER READING IS 0.3 VOLT OR LESS, IGNITION SWITCH AND RELAY TO SWITCH WIRE ARE SATISFACTORY
11. IF VOLTMETER READING IS GREATER THAN 0.3 VOLT:
    a. IGNITION SWITCH IS DAMAGED
    b. RELAY TO SWITCH WIRE IS DAMAGED
    c. SWITCH AND WIRE ARE BOTH DAMAGED

D. RESISTANCE WIRE VOLTAGE TEST

1. CHECK VEHICLE WIRING DIAGRAM, LOCATE DISCONNECT FOR IGNITION SWITCH LEAD
2. SEPARATE WIRING HARNESS SWITCH LEAD FROM SWITCH
3. FABRICATE JUMPER LEAD
    a. USE WIRE SIMILAR TO IGNITION SWITCH LEAD
    b. DETERMINE LENGTH OF WIRE NEEDED
    c. REMOVE ¼ INCH OF INSULATION FROM EACH END OF WIRE
    d. INSTALL FEMALE CONNECTOR ON ONE END OF JUMPER
    e. INSTALL MALE CONNECTOR ON SECOND END OF JUMPER
4. INSTALL END OF JUMPER LEAD ON IGNITION SWITCH LEAD

5. CONNECT POSITIVE LEAD OF VOLTMETER TO SECOND END OF JUMPER
6. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE
7. INSTALL BARE METAL EXTENSION BETWEEN PRIMARY COIL SWITCH LEAD AND COIL TERMINAL
8. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE METAL EXTENSION
9. GROUND PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE
10. TURN OFF ALL ACCESSORIES AND LIGHTS
11. TURN THE IGNITION SWITCH TO ON POSITION
12. OBSERVE VOLTMETER READING
13. IF VOLTMETER READING IS BETWEEN 6.6 AND 4.5 VOLTS, RESISTANCE WIRE IS SATISFACTORY
14. IF VOLTMETER READING IS GREATER THAN 6.6 VOLTS OR LESS THAN 4.5 VOLTS, REPLACE RESISTANCE WIRE
15. REMOVE TEST EQUIPMENT, MAKE ALL NECESSARY CONNECTIONS

E. COIL TO GROUND VOLTMETER TEST

1. REMOVE COIL PRIMARY LEAD, DISTRIBUTOR SIDE
2. CONNECT BARE METAL EXTENSION BETWEEN COIL PRIMARY LEAD AND COIL TERMINAL
3. CONNECT PRIMARY LEAD OF VOLTMETER TO METAL EXTENSION
4. GROUND VOLTMETER NEGATIVE LEAD
5. REMOVE DISTRIBUTOR CAP
6. TURN ENGINE OVER
7. CLOSE BREAKER POINT CONTACTS
8. INSTALL DISTRIBUTOR CAP ON THE DISTRIBUTOR
9. TURN OFF ACCESSORIES AND LIGHTS
10. TURN THE IGNITION SWITCH TO ON POSITION
11. OBSERVE VOLTMETER READING
12. IF VOLTMETER READING IS 0.25 VOLT OR LESS, PRIMARY CIRCUIT FROM COIL TO GROUND IS SATISFACTORY

13. IF VOLTMETER READING IS GREATER THAN 9.25 VOLT, TEST VOLTAGE DROP BETWEEN EACH OF THE FOLLOWING:
    a. COIL AND BREAKER POINT PRIMARY LEAD CONNECTIONS
    b. MOVABLE BREAKER POINT
    c. BREAKER PLATE

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PRACTICE ON TASKS UNDER CLOSE SUPERVISION.
2. USE JOB AND TASK SHEETS.
3. RETEACH IF THE NEED ARISES.
4. USE CHECKING STANDARDS AS OUTLINED IN HEADING OF LESSON TO CHECK STUDENT'S PERFORMANCE.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON THEIR OWN.
2. USE PERFORMANCE TEST.
3. RECORD SATISFACTORY STUDENT PERFORMANCE IN PROGRESS CHART.
4. IF PERFORMANCE IS NOT SATISFACTORY, RETEACH.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY WHEN DEALING WITH ELECTRICITY.
2. POINT OUT FUNCTION, DIFFERENCE, AND TEST FOR PRIMARY AND SECONDARY CIRCUITS.
3. EMPHASIZE NEED AND NECESSITY FOR MAKING CORRECT TEST HOOKUPS.
4. EMPHASIZE NEED FOR CORRECT TEST RESULTS AND SERVICE NECESSARY TO CORRECT PROBLEMS

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 292-294
AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436

THE NEXT LESSON IS: VIII-C-3(S), "TEST AUTOMOBILE CRANKING SYSTEM"

VIII-C-2(J)

# JOB SHEET
# IN
# IGNITION SYSTEM

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**MATERIALS:** CLEAN RAGS, HEAT RESISTANT LUBRICANT

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROP LIGHT, TACH AND DWELL METER, VOLTMETER, HAND TOOLS, AUXILIARY STARTER SWITCH

**GENERAL INSTRUCTIONS:** BEFORE STARTING THE JOB READ REFERENCES AND STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE STARTING ENGINE AND AFTER MAKING TEST HOOKUPS PRIOR TO PERFORMING TASKS.

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-C-2(TS) | ISOLATE PROBLEM CIRCUIT |
| VIII-C-2a(TS) | MAKE BATTERY TO COIL TEST |
| VIII-C-2b(TS) | TEST STARTING IGNITION CIRCUIT |
| VIII-C-2c(TS) | TEST IGNITION SWITCH AND RESISTANCE WIRE |
| VIII-C-2d(TS) | PERFORM COIL TO GROUND TEST |

## TASK SHEET

VIII-C-2(TS)

| | |
|---|---|
| TASK: | ISOLATE PROBLEM CIRCUIT |
| JOB: | ISOLATE IGNITION PROBLEMS ON VEHICLE |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | FENDER COVERS, SEAT COVER, HAND TOOLS, DROP LIGHT, AUXILIARY STARTER SWITCH, HIGH TENSION IGNITION PLIERS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. CONNECT AUXILIARY STARTER INTO STARTING CIRCUIT |
| | 2. REMOVE COIL SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP |
| | NOTE: THIS TEST IS NOT TO BE PERFORMED ON VEHICLES EQUIPPED WITH ELECTRONIC IGNITION BECAUSE OF SAFETY FACTOR |
| | 3. USE HIGH TENSION IGNITION PLIERS TO HOLD SECONDARY WIRE |
| 2. PERFORM TEST | 1. HOLD END OF COIL SECONDARY WIRE APPROXIMATELY 3/16 INCH FROM CYLINDER HEAD OR ANY GOOD GROUND |
| | 2. CRANK ENGINE OVER WITH AUXILIARY STARTER |
| | 3. STRONG SPARK INDICATES TROUBLE IS IN PRIMARY CIRCUIT |
| | 4. WEAK OR NO SPARK INDICATES TROUBLE IS IN THE SECONDARY CIRCUIT<br>a. COIL TO DISTRIBUTOR HIGH TENSION LEAD<br>b. COIL |
| | 5. PREPARE TO TEST MALFUNCTIONING CIRCUIT |

# TASK SHEET

VIII-C-2a(TS)

**TASK:** MAKE BATTERY TO COIL TEST

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVERS, DROP LIGHT, HAND TOOLS, METAL ELECTRICAL EXTENSION, VOLTMETER, JUMPER LEAD

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE |
| | 2. INSTALL BARE METAL EXTENSION ON PRIMARY TERMINAL ON SWITCH SIDE OF COIL |
| | 3. INSTALL SWITCH SIDE PRIMARY COIL LEAD ON METAL EXTENSION |
| | 4. CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION ON COIL |
| | 5. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF THE BATTERY |
| | 6. REMOVE PRIMARY LEAD FROM DISTRIBUTOR SIDE OF COIL |
| | 7. INSTALL JUMPER WIRE ON PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE |
| | 8. GROUND OPPOSITE END OF JUMPER LEAD ON DISTRIBUTOR HOUSING |
| | 9. TURN OFF ALL LIGHTS AND ACCESSORIES |
| 2. PERFORM TEST | 1. TURN THE IGNITION SWITCH TO ON POSITION |
| | 2. CHECK VOLTMETER READING |
| | 3. A READING BETWEEN 4.5 AND 6.9 VOLTS INDICATES PRIMARY CIRCUIT FROM BATTERY TO COIL IS SATISFACTORY |
| | 4. IF READING ON VOLTMETER EXCEEDS 6.9 VOLTS CHECK: |
| | a. BATTERY POST AND CABLES FOR CORROSION OR LOOSE CONNECTION |

| STEPS | KEY POINTS |
|---|---|
|  | b. PRIMARY WIRING FOR<br>(1) DAMAGED OR WORN INSULATION<br>(2) BROKEN STRANDS OF WIRE<br>(3) LOOSE OR CORRODED CONNECTIONS<br>5. IF READING IS LESS THAN 4.5 VOLTS:<br>a. REPLACE IGNITION RESISTANCE WIRE<br>b. CHECK STARTER RELAY TO IGNITION SWITCH FOR DAMAGE<br>6. DISCONNECT ALL TEST CONNECTIONS<br>7. MAKE ALL NORMAL HOOKUPS |

## TASK SHEET

VIII-C-2b(TS)

TASK: TEST STARTING IGNITION CIRCUIT

JOB: ISOLATE IGNITION PROBLEMS ON THE VEHICLE

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROP LIGHT, VOLTMETER, AUXILIARY STARTER SWITCH, METAL EXTENSION

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. INSTALL AUXILIARY STARTER SWITCH INTO STARTING CIRCUIT<br>2. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE<br>3. INSTALL BARE METAL EXTENSION ON SWITCH SIDE OF COIL, PRIMARY TERMINAL<br>4. CONNECT COIL SWITCH SIDE PRIMARY LEAD TO BARE METAL EXTENSION ON COIL<br>5. CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION ON COIL<br>6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF BATTERY<br>7. REMOVE COIL TO DISTRIBUTOR SECONDARY WIRE FROM CENTER TOWER OF DISTRIBUTOR CAP<br>8. GROUND SECONDARY COIL WIRE<br>9. THE IGNITION SWITCH IS TO BE IN OFF POSITION |
| 2. PERFORM TEST | 1. CRANK ENGINE OVER WITH AUXILIARY STARTER SWITCH<br>2. OBSERVE VOLTMETER, CHECK FOR VOLTAGE DROP<br>3. A VOLTAGE DROP OF 0.4 VOLT OR LESS INDICATES THAT THE STARTING IGNITION CIRCUIT IS SATISFACTORY<br>4. IF VOLTAGE DROP IS GREATER THAN 0.4 VOLT:<br>a. CLEAN AND TIGHTEN ALL TERMINALS IN THE CIRCUIT<br>b. OR REPLACE WIRING AS NEEDED<br>5. DISCONNECT TEST HOOKUP<br>6. MAKE ALL NORMAL HOOKUPS |

# TASK SHEET

VIII-C-2c(TS)

**TASK:** TEST IGNITION SWITCH AND RESISTANCE WIRE

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FENDER COVERS, SEAT COVER, DROP LIGHT, VEHICLE WIRING DIAGRAM, JUMPER LEAD, VOLTMETER, METAL EXTENSION, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. FABRICATE JUMPER LEAD | 1. USE WIRE VERY SIMILAR TO OR SAME TYPE AS IGNITION PRIMARY WIRE<br>2. DETERMINE LENGTH OF WIRE NEEDED<br>3. PEEL $\frac{1}{4}$ INCH OF INSULATION FROM EACH END OF WIRE<br>4. PEEL $\frac{1}{2}$ INCH OF INSULATION FROM CENTER SECTION OF WIRE<br>5. SELECT MALE AND FEMALE WIRE TERMINALS COMPARABLE TO TERMINALS ON VEHICLE SWITCH WIRE AND SWITCH<br>6. INSTALL TERMINALS ON ENDS OF THE JUMPER WIRE, MAKE SURE TERMINALS ARE FIRMLY ATTACHED TO WIRE FOR GOOD ELECTRICAL CONTACT |
| 2. MAKE TEST HOOK UP FOR IGNITION SWITCH | 1. CHECK VEHICLE WIRING DIAGRAM, LOCATE DISCONNECT FOR IGNITION SWITCH LEAD<br>2. SEPARATE WIRING HARNESS SWITCH LEAD FROM IGNITION SWITCH<br>3. CONNECT FABRICATED JUMPER LEAD TO IGNITION SWITCH TERMINAL<br>4. CONNECT SECOND END OF JUMPER LEAD TO SWITCH PRIMARY LEAD IN WIRING HARNESS<br>5. CONNECT NEGATIVE LEAD OF VOLTMETER TO BARE MIDDLE SECTION OF JUMPER LEAD<br>6. CONNECT POSITIVE LEAD OF VOLTMETER TO POSITIVE POST OF BATTERY |

| STEPS | KEY POINTS |
|---|---|
| | 7. DISCONNECT DISTRIBUTOR PRIMARY LEAD FROM COIL |
| | 8. CONNECT A JUMPER LEAD TO DISTRIBUTOR PRIMARY TERMINAL ON COIL |
| | 9. GROUND OPPOSITE END OF JUMPER TO A GOOD GROUND ON DISTRIBUTOR HOUSING |
| | 10. TURN OFF ALL ACCESSORIES AND LIGHTS |
| 3. TEST IGNITION SWITCH | 1. TURN IGNITION SWITCH TO ON POSITION |
| | 2. OBSERVE VOLTMETER READING |
| | 3. READING OF 0.3 VOLT OR LESS, IGNITION SWITCH ARE RELAY TO SWITCH WIRE ARE SATISFACTORY |
| | 4. IF VOLTMETER READING IS GREATER THAN 0.3 VOLTS: |
| | a. IGNITION SWITCH IS DAMAGED |
| | b. RELAY TO SWITCH WIRE IS DAMAGED |
| | c. SWITCH AND WIRE ARE BOTH DAMAGED |
| | 5. REMOVE TEST HOOKUP |
| | 6. TURN OFF IGNITION SWITCH |
| 4. MAKE TEST HOOKUP OF RESISTANCE WIRE | 1. USE FABRICATED JUMPER LEAD TAPE BARE CENTER SECTION FOR INSULATION |
| | 2. INSERT JUMPER LEAD INTO IGNITION SWITCH LEAD |
| | 3. CONNECT POSITIVE LEAD OF VOLTMETER TO OPPOSITE END OF JUMPER |
| | 4. REMOVE PRIMARY LEAD FROM COIL, SWITCH SIDE |
| | 5. CONNECT BARE METAL EXTENSION TO SWITCH SIDE OF COIL |
| | 6. CONNECT PRIMARY SWITCH LEAD TO BARE METAL EXTENSION ON COIL |
| | 7. CONNECT NEGATIVE LEAD OF VOLTMETER TO METAL EXTENSION |
| | 8. GROUND PRIMARY TERMINAL OF COIL, DISTRIBUTOR SIDE |
| | 9. TURN OFF ALL ACCESSORIES AND LIGHTS |

| STEPS | KEY POINTS |
|---|---|
| 5. TEST RESISTANCE WIRE | 1. TURN IGNITION SWITCH TO ON POSITION |
| | 2. OBSERVE VOLTMETER READING |
| | 3. READING BETWEEN 6.6 AND 4.5 VOLTS INDICATES WIRE IS SATISFACTORY |
| | 4. IF VOLTAGE READING IS GREATER THAN 6.6 VOLTS OR LESS THAN 4.5 VOLTS, REPLACE RESISTANCE WIRE |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. MAKE ALL NECESSARY NORMAL CONNECTIONS |

TASK SHEET VIII-C-2d(TS)

**TASK:** PERFORM COIL TO GROUND TEST

**JOB:** ISOLATE IGNITION PROBLEMS ON THE VEHICLE

**TRADE:** AUTOMECHANICS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROP LIGHT, METAL EXTENSION, VOLTMETER, HAND TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. REMOVE PRIMARY LEAD FROM COIL, DISTRIBUTOR SIDE<br>2. CONNECT BARE METAL EXTENSION TO COIL TERMINAL, DISTRIBUTOR SIDE<br>3. CONNECT PRIMARY DISTRIBUTOR LEAD TO METAL EXTENSION<br>4. CONNECT PRIMARY LEAD OF VOLTMETER TO METAL EXTENSION<br>5. GROUND NEGATIVE LEAD OF VOLTMETER<br>6. REMOVE DISTRIBUTOR CAP<br>7. TURN ENGINE OVER AND CLOSE THE BREAKER POINT CONTACTS<br>8. INSTALL DISTRIBUTOR CAP<br>9. TURN OFF ALL ACCESSORIES AND LIGHTS |
| 2. PERFORM TEST | 1. TURN IGNITION SWITCH TO ON POSITION<br>2. OBSERVE VOLTMETER READING<br>3. A READING OF 0.25 VOLT OR LESS INDICATES PRIMARY CIRCUIT FROM COIL TO GROUND IS SATISFACTORY<br>4. IF VOLTMETER READING IS GREATER THAN 0.25 VOLTS, TEST VOLTAGE DROP BETWEEN EACH OF THE FOLLOWING:<br>a. COIL AND BREAKER POINT TERMINAL LEAD CONNECTIONS<br>b. MOVABLE BREAKER POINT<br>c. BREAKER PLATE |
| 3. CLEAN WORK STATION | 1. AS IN PRECEDING TASKS |

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

VIII-C-3(S)

| | |
|---|---|
| TASK: | TEST AUTOMOBILE CRANKING SYSTEM |
| AIMS: | 1. THE STUDENT WILL BE ABLE TO TEST FOR AND DIAGNOSE AUTOMOBILE ENGINE CRANKING SYSTEM TROUBLES.<br>2. THE STUDENT WILL BE ABLE TO UTILIZE AND ADJUST AUTOMOBILE CRANKING SYSTEM TEST EQUIPMENT IN ORDER TO DIAGNOSE AUTOMOBILE CRANKING SYSTEMS.<br>3. THE STUDENT WILL BE ABLE TO MAKE JUDGMENTS AND DECISIONS CONCERNING THE OVERHAUL, SERVICE, OR MAINTENANCE OF THE AUTOMOBILE CRANKING SYSTEM. |
| TOOLS AND EQUIPMENT: | BATTERY TEST EQUIPMENT, STARTER TEST EQUIPMENT |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | TRANSPARENCIES, FIGS. 202-206 |
| REFERENCES: | AUTOMECHANICS, CH. 9<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 371-385<br>AUTO SERVICE AND REPAIR, CH. 22<br>AUTOMOTIVE MECHANICS, CH. 23 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE COMPLETED THE RELATED LESSON ON BASIC ELECTRICITY, STUDIED THE REFERENCE MATERIAL, AND PERFORMED THE JOB OF "TEST THE STORAGE BATTERY" |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. PRACTICE SAFE WORKING HABITS<br>3. PROPERLY ADJUST AND USE TEST EQUIPMENT<br>4. APPRECIATION FOR TEST EQUIPMENT AND CUSTOMER'S VEHICLE<br>5. COOPERATION WITH INSTRUCTOR AND CO-WORKERS<br>6. CRAFTSMANLIKE PERFORMANCE OF JOB AND ADHERENCE TO STANDARDS SET BY MANUFACTURERS FOR SPECIFICATIONS. |

---

## I. PREPARATION (OF THE LEARNER)

AT ONE TIME VEHICLE ENGINES WERE STARTED WITH A HAND CRANK, WHICH RESULTED IN MANY BROKEN ARMS, SPRAINED WRISTS AND ELBOWS, AS WELL AS DAMAGED RADIATORS FROM FLYING CRANKS.

## I. PREPARATION (CON'T.)

IN ORDER FOR THE MANUFACTURER TO SELL VEHICLES TO THE FEMALE POPULATION SOME EASIER MEANS OF STARTING AN ENGINE BECAME NECESSARY.

AT THE OUTSET THE STARTER BUTTON WAS IN THE FLOORBOARD CLOSE TO THE FRONT SEAT AND THE OPERATOR STAMPED ON IT WITH THE HEEL OF THE FOOT. PROGRESSIVELY THE STARTER SWITCH HAS MOVED AROUND FROM PLACE TO PLACE ON THE FLOORBOARD, DASH, AND FINALLY TO THE IGNITION KEY.

TODAY THE CRANK SOCKET REMAINS ON THE FRONT OF THE CRANKSHAFT, BUT THERE IS NO ACCESS HOLE IN THE BUMPER OR GRILL. NEITHER DOES A CRANK COME WITH THE AUTOMOBILE AS AN ACCESSORY.

## II. PRESENTATION (OF THE MATERIAL)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. TEST THE STORAGE BATTERY | 1. FOR PROPER OPERATION<br>2. AS IN JOB VIII-A-2(J) |
| 2. CHECK TERMINALS | 1. CORROSION<br>2. TIGHT<br>3. BROKEN WIRES |
| 3. TEST GROUND CIRCUIT | 1. FOR VOLTAGE LOSS<br>2. BETWEEN GROUNDED BATTERY TERMINAL AND VEHICLE FRAME OR ENGINE BLOCK<br>3. USE VOLTMETER<br>4. REMOVE IGNITION WIRE FROM COIL POST TO PREVENT ENGINE STARTING<br>5. CONNECT VOLTMETER TO NEGATIVE POST OF BATTERY AND TO GROUND POINT<br>6. CRANK ENGINE OVER AND OBSERVE VOLTAGE READING. VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT<br>NOTE: STARTER IS NOT TO BE RUN IN EXCESS OF 30 SECONDS AT ANY ONE TIME<br>7. EXCESSIVE VOLTAGE DROP IS CAUSED BY BAD CONNECTION, STARTER, BATTERY, CABLE, GROUND |
| 4. TEST BETWEEN GROUND AND STARTER FIELD FRAME | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER |

3. ATTACH VOLTMETER TO THE VEHICLE FRAME OR ENGINE BLOCK DEPENDING ON BATTERY GROUND TERMINAL
4. ATTACH VOLTMETER TO THE STARTER FIELD FRAME
5. CRANK ENGINE OVER AND OBSERVE VOLTMETER READING
6. VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT
7. EXCESSIVE VOLTAGE DROP, BAD CONNECTION

5. TEST INSULATED CIRCUIT
    1. FOR VOLTAGE LOSS
    2. USE VOLTMETER
    3. ATTACH VOLTMETER TO THE BATTERY TERMINAL POST
    4. ATTACH VOLTMETER TO STARTING MOTOR TERMINAL STUD (SOLENOID EQUIPPED, USE BATTERY TERMINAL STUD ON SOLENOID)
    5. CRANK ENGINE OVER AND OBSERVE VOLTMETER READING
    6. VOLTAGE DROP SHOULD NOT BE MORE THAN .01 VOLT FOR NORMAL LENGTH, SHORT, INSULATED LEAD

        NOTE: IF EXCESSIVELY LONG INSULATED LEAD IS USED

        a. CHECK SEVERAL OTHER VEHICLES WITH SAME HOOK UP TO DETERMINE RESISTANCE
        b. USE NEW INSULATED CABLE TO CHECK RESISTANCE AND DROP
        c. CALCULATE RESISTANCE FOR INSULATED LEAD ON VEHICLE
    7. EXCESSIVE VOLTAGE DROP BAD CONNECTIONS, BATTERY, STARTER, CABLE, GROUND

6. TEST SAFETY LOCK OUT SWITCH
    1. AUTOMATIC TRANSMISSIONS
    2. FOR PROPER ADJUSTMENT, ACCORDING TO MANUFACTURER'S SPECIFICATIONS
    3. FOR MECHANICAL FAILURE

7. LOAD TEST STARTER
    1. AMPERAGE DRAW TEST ON VEHICLE

2. TO DETERMINE WHETHER OR NOT STARTING MOTOR MUST BE REMOVED FOR STALL AND NO-LOAD TEST
3. ENGINE TO BE STARTED AND RUN UNTIL NORMAL OPERATING TEMPERATURE IS OBTAINED
4. STOP ENGINE
5. REMOVE PRIMARY LEAD FROM IGNITION COIL
6. CONNECT TEST EQUIPMENT
    a. TO BATTERY
    b. LARGE LEADS
        (1) RED TO POSITIVE POST
        (2) BLACK TO NEGATIVE POST
    c. SMALL LEADS
        (1) DRIVE ICE PICK INTO EACH BATTERY POST
        (2) CONNECT RED LEAD TO PICK IN POSITIVE
        (3) CONNECT BLACK TO PICK IN NEGATIVE POST
7. CONNECT REMOTE STARTER JUMPER TO STARTER RELAY SWITCH
    a. RED LEAD BATTERY TERMINAL
    b. BLACK LEAD ON STARTER TERMINAL ACCORDING TO TYPE RELAY
8. ADJUST VARIABLE RESISTANCE OF TESTER TO MAXIMUM

    NOTE: THIS IS TO PREVENT CURRENT FROM FLOWING THROUGH AMMETER

9. CRANK ENGINE FOR 15 SECONDS
10. NOTE EXACT READING ON VOLTMETER
11. STOP CRANKING ENGINE
12. ADJUST VARIABLE RESISTANCE OF THE TESTER TO READ SAME VOLTAGES AS WHEN CRANKING ENGINE
13. CRANK ENGINE
14. NOTE AMPERAGE DRAW

    NOTE: THIS AMPERAGE DRAW IS AMPERAGE USED BY STARTER UNDER LOAD

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## II. PRESENTATION (CON'T.)

| | |
|---|---|
| | 15. COMPARE AMPERAGE DRAW NOTED IN KEY POINT 14 WITH MANUFACTURER'S SPECIFICATIONS<br>NOTE: USUALLY AMPERAGE DRAW IS FROM 150 TO 200 AMPS |
| 8. CLEAN WORK STATION | 1. REMOVE THE TEST EQUIPMENT FROM CRANKING SYSTEM<br>2. REPLACE PRIMARY LEAD ON IGNITION COIL<br>3. CLEAN WORK STATION AS IN PREVIOUS TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. CHECK STUDENTS FOR KEY POINTS
2. STUDENTS TO PRACTICE JOB UNDER CLOSE SUPERVISION

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

USE PERFORMANCE TEST, PUT STUDENTS ON THEIR OWN TO PERFORM THE TASKS OF THEIR JOB.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT STEPS FROM STAGE II AND EMPHASIZE NEED FOR FOLLOWING TEST PROCEDURE.
2. REEMPHASIZE NEED FOR SAFETY AND SAFETY FACTORS.
3. COVER PERTINENT KEY POINTS.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 8
AUTOMOTIVE ENCYCLOPEDIA, PP. 440-450
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CHS. 13, 23

THE NEXT LESSON IS: VIII-B-1(S), "SERVICE SPARK PLUGS"

THE NEXT LESSON IN THIS SERIES IS: VIII-C-5(S), "REMOVE AND REPLACE SECONDARY IGNITION WIRES"

VIII-C-3(J)

# JOB SHEET
# IN
# CRANKING SYSTEM

**JOB:** TEST AUTOMOTIVE CRANKING SYSTEM

**MATERIALS:**

**TOOLS AND EQUIPMENT:** BATTERY-STARTER TESTER, 2 ICE PICKS, BATTERY TERMINAL TOOLS, REMOTE STARTER JUMPER

**GENERAL INSTRUCTIONS:** ELECTRIC STARTING MOTORS ARE DESIGNED PRINCIPALLY FOR THE PURPOSE OF ROTATING INTERNAL COMBUSTION OF CARBURETION, COMPRESSION, AND IGNITION WHICH WILL CAUSE THE ENGINE TO START.

CHECKING THE STARTER AND STARTER CIRCUIT ON A REGULAR BASIS IS IMPORTANT IN ORDER TO PREVENT FAILURE AT INOPPORTUNE TIMES.

WITH ANY ELECTICAL EQUIPMENT OR UNIT THE LOGICAL PLACE TO START IS WITH THE BATTERY.

IN THIS JOB ALL TESTS WILL BE MADE WITH THE STARTER AND ACCESSORIES ON THE VEHICLE.

**PROCEDURE:**

| | |
|---|---|
| | TEST BATTERY AS IN JOB VIII-C-1(J) |
| VIII-C-3(TS) | STARTING CIRCUIT TEST |
| VIII-C-3a(TS) | LOAD TEST STARTER |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR PROPER COMPLETION OF JOB

CLEAN WORK STATION AS IN PRECEDING TASKS

TASK SHEET VIII-C-3(TS)

|  |  |
|---|---|
| TASK: | STARTING CIRCUIT TEST |
| JOB: | TEST AUTOMOTIVE CRANKING SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | MANUFACTURER'S SPECIFICATIONS, VOLTMETER, HAND TOOLS, ASSORTED OPEN END, REMOTE STARTER JUMPER |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CONNECT REMOTE STARTER JUMPER | 1. ON STARTER RELAY SWITCH<br>2. ONE LEAD ON BATTERY TERMINAL OF RELAY ACCORDING TO HOT SIDE OF BATTERY<br>3. ONE LEAD ON STARTER TERMINAL OF RELAY |
| 2. TEST INSULATED CIRCUIT | 1. FOR VOLTAGE LOSS<br>2. USE VOLTMETER<br>3. ATTACH VOLTMETER TO UNGROUNDED TERMINAL OF BATTERY<br>a. NEGATIVE LEAD OF VOLTMETER TO THE NEGATIVE POST IF UNGROUNDED<br>b. POSITIVE LEAD OF VOLTMETER TO POSITIVE POST IF UNGROUNDED<br>4. ATTACH REMAINING LEAD OF VOLTMETER TO STARTING MOTOR TERMINAL STUD<br>NOTE: SOLENOID EQUIPPED STARTER, USE BATTERY TERMINAL STUD ON SOLENOID<br>5. REMOVE PRIMARY LEAD FROM COIL TO KEEP ENGINE FROM STARTING<br>6. USE REMOTE STARTER, CRANK ENGINE FOR 15 SECONDS<br>7. OBSERVE THE VOLTMETER READING, VOLTAGE DROP SHOULD NOT BE MORE THAN .01 VOLT FOR NORMAL LENGTH, SHORT, INSULATED LEAD<br>NOTE: IF EXCESSIVELY LONG INSULATED LEAD IS USED |

| STEPS | KEY POINTS |
|---|---|
| | a. CHECK SEVERAL VEHICLES WITH SAME HOOK UP TO DETERMINE RESISTANCE |
| | b. USE NEW INSULATED CABLE TO CHECK RESISTANCE AND VOLTAGE DROP |
| | c. CALCULATE THE RESISTANCE FOR LONG INSULATED LEAD ON VEHICLE |
| | 8. EXCESSIVE VOLTAGE DROP INDICATES POSSIBLE BAD CONNECTIONS:<br>BATTERY<br>STARTER<br>CABLE<br>GROUND |
| 3. TEST GROUND CIRCUIT | 1. FOR VOLTAGE LOSS |
| | 2. USE VOLTMETER |
| | 3. ATTACH VOLTMETER TO GROUNDED BATTERY TERMINAL |
| | 4. ATTACH SECOND LEAD OF VOLTMETER TO FRAME OR VEHICLE ENGINE BLOCK DEPENDING ON WHERE GROUND STRAP IS ANCHORED |
| | 5. ATTACH REMOTES STARTER SWITCH AS IN STEP 1 |
| | 6. REMOVE PRIMARY WIRE FROM IGNITION COIL |
| | 7. USE REMOTES STARTER SWITCH CRANK |
| | 8. OBSERVE THE VOLTMETER READING , VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT |
| | 9. EXCESSIVE VOLTAGE DROP, CHECK KEY POINT 8 OF STEP 2 |
| 4. TEST BETWEEN GROUND AND STARTER FIELD FRAME | 1. FOR VOLTAGE LOSS |
| | 2. USE VOLTMETER |
| | 3. USE REMOTE STARTER SWITCH AS IN STEP 1 |
| | 4. REMOVE PRIMARY LEAD FROM IGNITION COIL |
| | 5. ATTACH ONE LEAD OF VOLTMETER TO VEHICLE FRAME OR ENGINE BLOCK |

| STEPS | KEY POINTS |
|---|---|
| | DEPENDING ON WHERE GROUND STRAP IS ANCHORED<br>6. ATTACH REMAINING VOLTMETER TO STARTER FIELD FRAME<br>7. USE THE REMOTE STARTER SWITCH, CRANK ENGINE FOR 15 SECONDS<br>8. OBSERVE THE VOLTMETER READING, VOLTAGE DROP SHOULD NOT EXCEED .01 VOLT<br>9. EXCESSIVE VOLTAGE DROP SEE KEY POINT 8 OF STEP 2 |
| 5. TEST SAFETY LOCK OUT SWITCH | 1. AUTOMATIC TRANSMISSION<br>2. FOR PROPER ALIGNMENT AND ADJUSTMENT ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS<br>3. FOR MECHANICAL FAILURE |
| 6. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-3a(TS)

**TASK:** LOAD TEST STARTER

**JOB:** TEST AUTOMOTIVE CRANKING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** STARTER-BATTERY TESTER, REMOTE STARTER JUMPER, 2 ICE PICKS, BATTERY TERMINAL TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE | 1. START ENGINE<br>2. RUN ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED<br>3. STOP ENGINE<br>4. REMOVE PRIMARY LEAD FROM IGNITION COIL |
| 2. INSTALL REMOTE STARTER JUMPER | 1. ON STARTER RELAY SWITCH<br>2. ONE LEAD ON BATTERY TERMINAL OF RELAY ACCORDING TO HOT SIDE OF BATTERY<br>3. ONE LEAD ON STARTER TERMINAL OF RELAY |
| 3. CONNECT TEST EQUIPMENT | 1. BATTERY-STARTER TESTER<br>2. TO BATTERY<br>3. CONNECT LARGE LEADS<br>a. RED TO POSITIVE POST<br>b. BLACK TO NEGATIVE POST<br>4. GENTLY BUT FIRMLY TAP ONE ICE PICK INTO EACH BATTERY POST<br>5. CONNECT SMALL LEADS<br>a. RED LEAD TO PICK IN POSITIVE POST<br>b. BLACK LEAD TO PICK IN NEGATIVE POST |
| 4. ADJUST TESTER | 1. VARIABLE RESISTANCE<br>2. TO MAXIMUM RESISTANCE<br>NOTE: THIS ADJUSTMENT IS MADE IN ORDER TO PREVENT CURRENT FROM FLOWING THROUGH AMMETER<br>3. USE REMOTE STARTER SWITCH, CRANK |

| STEPS | KEY POINTS |
|---|---|
| | ENGINE FOR 15 SECONDS |
| | 4. NOTE EXACT READING ON VOLTMETER |
| | 5. STOP CRANKING ENGINE |
| | 6. READJUST VARIABLE RESISTANCE OF TESTER TO READ EXACTLY THE SAME VOLTAGES AS WHEN THE ENGINE WAS BEING CRANKED |
| 5. MAKE LOAD TEST | 1. USE REMOTE STARTER, CRANK ENGINE FOR 15 SECONDS |
| | 2. NOTE AMPERAGE DRAW |
| | NOTE: THIS AMPERAGE DRAW IS AMPERAGE USED BY THE STARTER UNDER LOAD |
| | 3. COMPARE AMPERAGE DRAW NOTED IN KEY POINT 2 WITH MANUFACTURER'S SPECIFICATIONS |
| | NOTE: THE USUAL AMPERAGE DRAW IS FROM 150 AMPS TO 200 AMPS. THE AMPERAGE DRAW TEST IS TO DETERMINE WHETHER OR NOT THE STARTING MOTOR MUST BE REMOVED FOR STALL AND NO-LOAD |
| 6. CLEAN WORK STATION | 1. AS IN PRECEDING TASKS |
| | 2. CHECK WITH INSTRUCTOR FOR COMPLETION OF TEST AND MAKE JUDGMENT OR DECISION CONCERNING DISPOSITION OF STARTER |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-9(I)

| | |
|---|---|
| SUBJECT: | SECONDARY WIRING |
| AIM: | THE STUDENT WILL BE ABLE TO IDENTIFY SECONDARY WIRING BY ITS LOCATION, CONSTRUCTION, AND FUNCTION AND DEFINE ITS RELATIONSHIP WITH FIRING ORDER AND VOLTAGE DISTRIBUTION. |
| TEACHING AIDS: | FILM: 20,000 VOLTS UNDER THE HOOD, DELCO-REMY DIVISION, GMC<br>TRANSPARENCIES I. ED. II. 7T., FIGS. 306-314<br>CHALKBOARD |
| MATERIALS: | CHALK, USED PRIMARY AND SECONDARY WIRES |
| REFERENCES: | AUTOMECHANICS, GLENN, CH. 10<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 435-436<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 21<br>AUTOMOTIVE MECHANICS, CROUSE, CH. 25 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THE LESSON. |

### I. PREPARATION (OF THE LEARNER - MOTIVATION)

HAVE YOU EVER BEEN WATCHING TV WHEN A CAR WENT BY ON THE STREET AND SUDDENLY YOUR TV PICTURE GOT SNOWY OR WENT OUT COMPLETELY? MAYBE THE SOUND HAD SO MUCH STATIC YOU COULD NOT UNDERSTAND IT. YOUR SET WAS PICKING UP SIGNALS FROMTHE SECONDARY WIRING OF THE CAR. THE CAUSE OF THIS AND WHAT CAN BE DONE TO CORRECT IT IS WHAT WE WILL DISCUSS NOW.

### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE OF SECONDARY CIRCUIT<br>SHOW: TRANSPARENCY FIG. 312-314 | 1. DELIVER HIGH VOLTAGE FOR IGNITION<br>a. SECONDARY WINDING OF COIL DELIVERS HIGH VOLTAGE TO HIGH TENSION TERMINAL OF COIL<br>b. HIGH TENSION CABLE CARRIES THE CURRENT TO CENTER TERMINAL OF DISTRIBUTOR<br>c. ROTOR IN DISTRIBUTOR RECEIVES CURRENT AND TRANSFERS CURRENT TO "CAP TOWERS" |

   - d. SPARK PLUG WIRES DELIVER CURRENT TO PLUGS
2. INSULATE HIGH VOLTAGE CURRENT
3. INSULATION MUST ALSO PROTECT FROM:
   - a. HEAT GENERATED BY HIGH VOLTAGE
   - b. VIBRATION FROM VEHICLE OPERATION
   - c. ABRASION FROM OIL AND GRIT BUILD-UP

B. HIGH TENSION CABLES

1. CONNECT COIL TERMINAL AND DISTRIBUTOR CAP
2. CONNECT DISTRIBUTOR CAP AND SPARK PLUG TERMINALS

SHOW: TRANSPARENCY FIG. 309

3. HAVE SMALLER CONDUCTORS BUT HEAVIER INSULATION THAN PRIMARY WIRES

NOTE: SHOW CONTRAST IN CONSTRUCTION OF PRIMARY AND SECONDARY WIRES BY STRIPPING AWAY INSULATION

C. TYPES OF SPARK PLUG WIRES

1. BEFORE 1961 COPPER OR ALUMINUM WAS USED FOR CONDUCTORS
2. AFTER 1961 CONDUCTORS WERE MADE OF CARBON IMPREGNATED LINEN
   - a. HAS RESISTOR EFFECT ON CURRENT SURGES
   - b. REDUCES PLUG ELECTRODE AND BREAKER POINT WEAR
   - c. PREVENTS INTERFERENCE WITH RADIO AND TV
   - d. WILL NOT TRANSMIT RADIO SIGNALS LIKE SOLID CONDUCTORS

SHOW: TRANSPARENCY FIGS. 308, 309

3. 1963--CARS BEGAN USING FIBER-GLASS CORES SATURATED WITH GRAPHITE
   - a. OPERATE SAME AS LINEN CORE
   - b. LESS BREAKAGE AND LESS TENDENCY TO BURN

CAUTION: ROUGH HANDLING OR SHARP BENDING CAN DAMAGE SECONDARY WIRES

D. FEDERAL REGULATIONS

1. ADMINISTERED BY FEDERAL COMMUNICATIONS COMMISSION

SHOW: TRANSPARENCY FIG. 310

2. NO METALLIC CONDUCTOR CABLES IN SECONDARY WIRING
3. METALLIC SECONDARY CABLES CAUSE R.F.I. (RADIO FREQUENCY INTERFERENCE)
4. INTERRUPTS OR INTERFERES WITH COMMUNICATION IN POLICE CARS, AMBULANCES, FIRE TRUCKS, ETC.
5. SECONDARY WIRING MUST HAVE BUILT-IN RESISTANCE

E. FIRING ORDER AND CYLINDER NUMBERING

1. CYLINDERS MUST FIRE IN AN ORDERED SEQUENCE
2. FOUR CYLINDER IN-LINE ENGINE
   a. CYLINDERS NUMBER FROM FRONT (1) TO BACK (4)
   b. FIRING ORDER IS 1-3-4-2 IN SOME MODELS
   c. FIRING ORDER IS 1-4-2-3 IN OTHER MODELS
3. SIX CYLINDER IN-LINE ENGINE
   a. CYLINDERS NUMBER FROM FRONT (1) TO BACK (6)
   b. FIRING ORDER IS 1-5-6-3-2-4 IN SOME MODELS
   c. FIRING ORDER IS 1-4-2-6-3-5 IN OTHER MODELS
4. SIX CYLINDER V-6 ENGINE (BUICK)
   a. CYLINDERS NUMBER FRONT TO BACK
   b. RIGHT BANK (FROM DRIVER'S SEAT) 2-4-6
   c. LEFT BANK (FROM DRIVER'S SEAT) 1-3-5
   d. FIRING ORDER IS 1-6-5-4-3-2

F. DISTRIBUTOR ROTATION

1. ROTATES AT HALF ENGINE SPEED
2. CAM AND ROTOR REVOLVE
   a. CAM ROTATION OPERATES THE BREAKER POINTS

SHOW: TRANSPARENCY FIG. 314

   b. ROTOR DELIVERS HIGH VOLTAGE SURGE TO SPARK PLUG WIRES
3. USUAL DIRECTION OF ROTOR ROTATION IS TO THE RIGHT

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT PARTS OF THE IGNITION CIRCUIT DO THE SECONDARY WIRES CONNECT?

ANSWER:

- a. COIL
- b. DISTRIBUTOR CAP
- c. SPARK PLUGS

2. WHAT DOES THE FEDERAL COMMUNICATIONS COMMISSION HAVE TO DO WITH THE AUTOMOTIVE INDUSTRY?

ANSWER: REGULATES TYPE OF WIRING IN SECONDARY CIRCUITS.

3. WHY IS COPPER NO LONGER USED IN SECONDARY CIRCUITS?

ANSWER: HIGH VOLTAGE IN SOLID WIRES SEND OUT RADIO SIGNALS.

4. DEFINE RESISTOR WIRE.

ANSWER: WIRE HAVING A CORE CONSTRUCTED OF NON-CONDUCTIVE MATERIAL SUCH AS LINEN OR FIBER-GLASS IMPREGNATED WITH CONDUCTIVE MATERIAL SUCH AS CARBON OR GRAPHITE.

5. ARE THERE ADVANTAGES OTHER THAN CUTTING DOWN R. F. I. IN USING RESISTOR CABLES IN THE SECONDARY?

ANSWER: YES. BREAKER POINTS AND PLUG ELECTRODES LAST LONGER.

6. HOW ARE CYLINDERS NUMBERED IN MOST IN-LINE ENGINES?

ANSWER: FROM FRONT (1) TO BACK (4) OR (6) OR (8).

7. WHAT SHOULD BE USED TO CHECK THE FIRING ORDER OF A V-8?

ANSWER: MANUFACTURER'S SPECIFICATIONS IN A SHOP MANUAL.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE TEST

| | | |
|---|---|---|
| 1. | SECONDARY WIRING IS ALSO CALLED HIGH TENSION CABLE. | T |
| 2. | CONDUCTORS IN SECONDARY WIRES ARE SMALLER THAN IN PRIMARY WIRES. | T |
| 3. | PRIMARY WIRES HAVE HEAVIER INSULATION THAN SECONDARY WIRES. | F |
| 4. | RESISTOR TYPE SECONDARY WIRE MAKES SPARK PLUGS LAST LONGER. | T |

## IV. VERIFICATION (CON'T.)

| | | |
|---|---|---|
| 5. | FIBER-GLASS CORES WERE THE FIRST TO BE USED IN RESISTOR WIRES. | F |
| 6. | THE CYLINDER NEAREST THE FRONT OF AN IN-LINE ENGINE HAS THE SMALLEST NUMBER. | T |
| 7. | CYLINDERS FIRE IN SPECIFIC ORDER. | |
| 8. | A ROTOR IN A DISTRIBUTOR ROTATES AT TWICE THE ENGINE SPEED. | F |
| 9. | FIRING ORDER AND CYLINDER NUMBER DETERMINE PLACEMENT OF THE SPARK PLUG WIRES. | T |
| 10. | A DISTRIBUTOR CAM ROTATES AT HALF ENGINE SPEED. | T |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

1. SECONDARY WIRING HANDLES HIGH VOLTAGE FROM COIL TO DISTRIBUTOR TO SPARK PLUGS.
2. TYPE OF WIRE IS IMPORTANT DUE TO THE TENDENCY OF SECONDARY TO TRANSMIT RADIO SIGNALS.
3. SECONDARY WIRING IN AUTOS IS REGULATED BY THE FEDERAL COMMUNICATIONS COMMISSION.
4. CYLINDER NUMBERING AND FIRING ORDER VARY BETWEEN MANUFACTURERS AND ENGINE DESIGNS.
5. AS THE ONLY PART OF THE SECONDARY CIRCUIT WITH MECHANICAL MOVEMENT, THE DISTRIBUTOR IS RESPONSIBLE FOR DELIVERY OF HIGH VOLTAGE TO THE RIGHT PLUG AT THE RIGHT TIME.

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SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CH. 25

THE NEXT LESSON IS: VIII-C-10(I), "SECONDARY VOLTAGE"

VIII-C-10(I)

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | SECONDARY VOLTAGE |
| AIM: | THE STUDENT WILL BE ABLE TO DESCRIBE SECONDARY VOLTAGE AS IT RELATES TO THE AUTOMOBILE'S IGNITION SYSTEM AND USE ELECTRICAL THEORY IN SOLVING PROBLEMS COMMONLY ENCOUNTERED IN SECONDARY SYSTEMS |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II. 7 T, FIGS. 307, 310-312, CHALKBOARD |
| MATERIALS: | CHALK, USED COIL OR DISTRIBUTOR CAP SHOWING CARBON TRACKS |
| REFERENCES: | AUTOMECHANICS, GLENN, CH. 10<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 435-436<br>AUTO SERVICE AND REPAIRS, STOCKEL, CH. 21<br>AUTOMOTIVE MECHANICS, CROUSE, CH. 25 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST BE THOROUGHLY FAMILIAR WITH MATERIALS PRESENTED IN PREVIOUS LESSONS, "SECONDARY WIRING." |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN THE LAST LESSON WE LEARNED ABOUT SECONDARY WIRING, ITS LOCATION AND ITS FUNCTION. NOW WE NEED TO KNOW MORE ABOUT THE VOLTAGE THE SECONDARY WIRING IS RESPONSIBLE FOR CONDUCTING, AND WHAT HAPPENS WHEN THE SECONDARY CANNOT HANDLE THAT VOLTAGE.

WE WILL ALSO SEE HOW THE WIRING CAN HANDLE THE CURRENT SO WELL IT REDUCES ITS EFFICIENCY.

---

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENT TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. GENERAL INFORMATION | 1. IGNITION COIL IS A TRANSFORMER<br>2. TRANSFORMS 12 OR LESS BATTERY VOLTS TO 20,000 OR MORE IN SECONDARY WIRING<br>3. IGNITION REQUIREMENTS VARY WITH ENGINE COMPRESSION<br>a. LOW RESISTANCE AT IDLE-4,000 TO 6,000 VOLTS WILL FIRE PLUG |

   b. HIGH SPEEDS REQUIRES UP TO 20,000 OR MORE VOLTS TO FIREPLUG

B. CURRENT LEAKAGE

1. CURRENT FOLLOWS PATH OF LEAST RESISTANCE
2. FOULED ELECTRIC TERMINALS INCREASE RESISTANCE
3. MOISTURE AND DUST IN MINUTE INSULATION CRACKS CAN CAUSE LEAKAGE
4. LEAKAGE REDUCES THE INTENSITY OF SPARK IN CYLINDER

C. RESISTANCE AND OHM'S LAW

SHOW: TRANSPARENCY FIG. 309

1. RESISTANCE IS WIRE'S TENDENCY TO RESIST ELECTRON FLOW
2. ALL THE CONDUCTORS HAVE NATURAL RESISTANCE
3. ELECTRICAL RESISTANCE MEASURED IN OHMS
4. ELECTRICAL PRESSURE IS VOLTS MINUS FORCE
   a. AREA OF HIGHER PRESSURE COMPARES TO WATER
   b. FLOWS TO AREA OF LOWER PRESSURE
5. RATE OF ELECTRON FLOW IS AMPERES MINUS INTENSITY
6. OHMS LAW
   a. $\text{OHMS} = \frac{\text{VOLTS}}{\text{AMPS}}$
   b. $\text{AMPS} = \frac{\text{VOLTS}}{\text{OHMS}}$
   c. VOLTS = OHMS X AMPS
7. BALANCE BETWEEN THE AMPERAGE, VOLTAGE, AND OHMS NECESSARY FOR BEST SERVICE

D. TEST PROCEDURES

SHOW: TRANSPARENCY FIG. 310

1. OHMMETER USED TO TEST SECONDARY WIRING
2. EACH WIRE TESTED SEPARATELY
3. MANUFACTURER'S SHOP MANUAL GIVES SPECIFICATIONS
4. RESISTANCE OF 16,000 OHMS OR MORE REQUIRES CABLE REPLACEMENT

5. HIGH RESISTANCE IN COIL TO DISTRIBUTOR WIRE MAY CAUSE ALL PLUGS TO MISS

CAUTION: RESISTOR PLUGS WITH RESISTOR CABLES REDUCE CURRENT TOO MUCH AT HIGHER SPEEDS

E. CARBON TRACKING

1. A FORM OF CURRENT LEAKAGE LEAVING A CARBON TRAIL
2. RESULT OF "FLASHOVER" OR HIGH VOLTAGE GOING TO GROUND OTHER THAN THROUGH CIRCUIT INTENDED
3. MAY OCCUR ANYWHERE IN SECONDARY BUT USUALLY:
   a. BETWEEN COIL TERMINALS
   b. BETWEEN THE DISTRIBUTOR TERMINALS, INSIDE OR OUTSIDE
   c. AT SPARK PLUG TERMINALS
4. CAUSED BY MOISTURE, DIRT, CORROSION, OR POOR CONNECTIONS

F. CROSS FIRING

SHOW: TRANSPARENCIES FIGS. 311, 312

1. PLUG WIRE JUMPS ITS CURRENT TO ANOTHER WIRE WITH ENOUGH VOLTAGE TO FIRE THE OTHER CYLINDER
2. MAY CAUSE MECHANICAL DAMAGE
3. PREVENTIVE MEASURES:
   a. KEEP PLUG WIRES CLEAN AND DRY
   b. AVOID BUNCHING WIRES
   c. PROPERLY SEPARATE AND SPACE WIRES

G. DISTRIBUTOR CAP

SHOW: TRANSPARENCY FIG. 307

1. COMPOSED OF DENSE, NON-CONDUCTIVE MATERIAL
2. CENTER TOWER RECEIVES COIL VOLTAGE
3. OUTER TOWERS FOR THE SPARK PLUG WIRES
4. ROTOR CONTACT INSIDE RECEIVES CURRENT
5. TERMINAL POSTS INSIDE DISTRIBUTE CURRENT
6. CAP MAY EITHER CLIP OR LATCH TO BASE

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. IN WHAT WAY IS AN IGNITION COIL A TRANSFORMER?

ANSWER: TRANSFORMS LOW VOLTAGE OF BATTERY TO 20,000 OR MORE.

2. WHAT IS MEANT BY CURRENT LEAKAGE?

ANSWER: ELECTRICITY IS LIKE WATER IN THAT IT FLOWS ALONG THE PATH OF LEAST RESISTANCE.

3. DEFINE RESISTANCE. WHAT UNIT IS IT MEASURED IN?

ANSWER: WIRE'S TENDENCY TO RESIST CURRENT FLOW. RESISTANCE IS MEASURED IN OHMS.

4. IF OHMS AND AMPERES ARE KNOWN, HOW CAN YOU FIGURE THE VOLTAGE?

ANSWER: OHMMETER

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE TEST

1. LOWER VOLTAGE IS REQUIRED TO FIRE A CYLINDER AT IDLE SPEED. T
2. ELECTRICAL PRESSURE OR FORCE IS CALLED VOLTAGE. T
3. AMPERES IS A MEASURE OF INTENSITY OF ELECTRON FLOW. T
4. SPARK PLUG WIRES WITH 4,000 OHMS RESISTANCE PER FOOT OF LENGTH SHOULD BE REPLACED. F
5. CARBON TRACKING SOMETIMES OCCURS BETWEEN BATTERY TERMINALS. T
6. CARBON TRACKING RESULTS FROM "FLASHOVER." F
7. CURRENT JUMPING WIRES TO FIRE THE WRONG CYLINDER IS CALLED CROSS FIRING. F
8. A WAY TO PREVENT CROSS FIRING IS TO BUNCH THE WIRES TOGETHER. F
9. COIL VOLTAGE IS DELIVERED TO THE CENTRAL TOWER OF THE DISTRIBUTOR CAP. T
10. THE ROTOR CONTACT IS IN DIRECT CONTACT WITH THE CENTRAL TOWER. T

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. IN THE SECONDARY, VOLTAGE IS JUMPED UP FROM A FEW VOLTS TO 20,000 OR MORE.
2. ELECTRIC CURRENT MAY BE COMPARED TO WATER IN ITS BEHAVIOR AND TENDENCY TO "LEAK".
3. VOLTAGE IS THE UNIT OF ELECTRICAL PRESSURE OR FORCE. AMPERES IS THE INTENSITY OR RATE OF ELECTRON FLOW. OHMS IS THE MEASURE OF RESISTANCE TO ELECTRON FLOW.
4. MANY FACTORS CAN CAUSE RESISTANCE TO INCREASE AND WIRES SHOULD BE CHECKED WITH AN OHMMETER PERIODICALLY.
5. CARBON TRACKING AND CROSS FIRING ARE DETERIMENTAL TO ENGINE OPERATION AND EFFICIENCY.
6. THE DISTRIBUTOR CAP IS THE PART OF THE SECONDARY THAT "HANDS OUT" VOLTAGE TO THE SPARK PLUG WIRES.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN, PP. 295-298

THE NEXT LESSON IS: VIII-B-3(I), "BREAKER POINTS"

THE NEXT LESSON IN THIS SERIES IS: VIII-C-14(I), "IGNITION RESISTER AND BY PASS"

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | REMOVE AND REPLACE SECONDARY IGNITION WIRES |
| AIM: | THE STUDENT WILL BE ABLE TO REMOVE OLD HIGH TENSION WIRING, SELECT PROPER REPLACEMENT WIRING, TEST WIRING FOR RESISTANCE, AND REPLACE WIRING IN PROPER FIRING ORDER ACCORDING TO SPECIFICATIONS. |
| TOOLS AND EQUIPMENT: | SPARK PLUG TERMINAL PLIERS, FENDER COVERS, SEAT COVER, DROP LIGHT, OHMMETER |
| MATERIALS: | SECONDARY WIRING SET |
| REFERENCES: | AUTOMOTIVE ENCYCLOPEDIA, PP. 447-449<br>AUTO SERVICE AND REPAIR, PP. 6-9 TO 6-10, 21-7 TO 21-9 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE SATISFACTORILY PERFORMED ON PRECEDING MATERIALS AND JOBS. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT.<br>2. VEHICLE PREPARATION.<br>3. STANDARDS OF WORKMANSHIP.<br>4. APPRECIATION FOR CUSTOMER'S VEHICLE, TOOLS, AND EQUIPMENT.<br>5. SAFE WORKING HABITS. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

TO KEEP AN ENGINE RUNNING AT PEAK PERFORMANCE, THE HIGH TENSION IGNITION WIRING MUST BE CHECKED AT PERIODIC INTERVALS.

WIRING REPLACEMENT BECOMES NECESSARY BECAUSE OF ENGINE HEAT, AGING OF INSULATION, OIL, GREASE, AND ELECTRICAL STRESSES.

ELECTRICAL STRESSES WILL CAUSE LOSS OF VOLTAGE AVAILABLE TO THE SPARK PLUGS. WIRING DEFECTS ARE NOT USUALLY NOTICED UNTIL THE EXTREME STAGES HAVE BEEN REACHED. EXTREME STAGES OF DETERIORATION APPEAR AS HARD WIRING INSULATION, STIFF WIRING, AND CRACKED INSULATION. IF WIRING IS HANDLED ROUGHLY THE CARBON-LIKE CONDUCTOR CAN BE SEPARATED, PRODUCING A GAP. THIS SEPARATION OF THE CONDUCTOR CAUSES AN ARCING AND BURNING OF THE CORE THREAD WHICH WILL EVENTUALLY CAUSE AN OPEN IN THE WIRING. BOOTS ON THE CABLE ENDS DETERIORATE MUCH FASTER THAN THE WIRING.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS |
| | 2. PREPARE VEHICLE FOR SERVICE AS IN PRECEDING TASKS |
| 2. REMOVE WIRES | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR FIRING ORDER |
| | 2. MARK DISTRIBUTOR CAP WITH CODE FOR REPLACING WIRES IN PROPER ORDER |
| | 3. USE RAG, WIPE GREASE AND DIRT FROM PLUG END OF WIRES AND BOOTS TO KEEP FOREIGN MATTER FROM FALLING DOWN AROUND SPARK PLUGS |
| | 4. GRASP BOOT ON SPARK PLUG END OF WIRE WITH SPARK PLUG TERMINAL PLIERS |
| | 5. TWIST WIRE FROM SIDE TO SIDE AND PULL WIRE FROM SPARK PLUG |
| | 6. REMOVE ALL WIRES FROM SPARK PLUGS AS IN KEY POINTS 4 AND 5 |
| | 7. NOTE POSITION OF WIRES THROUGH CONDUITS ON SUPPORT BRACKETS |
| | NOTE: WIRES MUST BE PLACED IN CONDUIT OR BRACKETS IN SUCH AN ORDER THAT THERE WILL BE NO CROSSFIRING OF WIRES LEADING TO CYLINDERS THAT FIRE IN SEQUENCE |
| | 8. REMOVE WIRES FROM DISTRIBUTOR CAP<br>a. GRASP BOOTS ON WIRE WITH THE SPARK PLUG TERMINAL PLIERS<br>b. TWIST WIRE BACK AND FORTH<br>c. PULL WIRES FROM DISTRIBUTOR CAP |
| | 9. REMOVE WIRES FROM CONDUIT OR BRACKET |
| | 10. REMOVE SECONDARY WIRE FROM COIL AND DISTRIBUTOR |
| 3. TEST WIRES FOR RESISTANCE | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR: |

a. PROPER REPLACEMENT WIRES
b. PLUG OHMMETER INTO POWER SOURCE
c. TOUCH WIRE CONDUCTOR WITH ONE PROBE OF OHMMETER AT EACH END
d. NOTE OHMMETER READING
e. CHECK THE OHMMETER READING AGAINST MANUFACTURER'S SPECIFICATIONS

CAUTION: ELECTRONIC IGNITION SECONDARY WIRING IS NOT TO BE TESTED BY PULLING WIRES FROM PLUGS WHILE ENGINE IS RUNNING BECAUSE OF EXCESSIVELY HIGH VOLTAGE

4. INSTALL SECONDARY WIRING

1. CHECK EACH WIRE TERMINAL END MAKING SURE THEY ARE FIRMLY IN PLACE
2. TAKE CARE NOT TO BEND OR FOLD WIRE OR OTHERWISE HANDLE THEM ROUGHLY
3. ARRANGE WIRES FROM DISTRIBUTOR TO SPARK PLUGS IN AN ORDER RECOMMENDED BY MANUFACTURER TO PREVENT CROSSFIRING
4. AVOID BUNCHING WIRES OR RUNNING THEM PARALLEL (SIDE BY SIDE)
5. KEEP WIRES APART AS FAR AS POSSIBLE
6. IN CASES WHERE TWO ADJACENT SPARK PLUGS FIRE IN SUCCESSION, SEPARATE THESE TWO WIRES WITH A THIRD WIRE
7. KEEP SPARK PLUG WIRES AS FAR AWAY FROM AREAS OF HEAT AND OIL AS POSSIBLE
8. INSERT FIRST WIRE TERMINAL IN DISTRIBUTOR CAM AND PRESS DOWN FIRMLY
9. FEED WIRE THROUGH CONDUIT OR PLACE IN BRACKET
10. PRESS OPPOSITE END OF WIRE ONTO SPARK PLUG MAKING SURE THAT BOOT IS DOWN OVER SPARK PLUG

## II. PRESENTATION (CON'T.)

| | |
|---|---|
| | 11. INSTALL REMAINING WIRES<br>a. ACCORDING TO FIRING ORDER<br>b. REPEAT KEY POINTS 8-10<br>c. KEEPING IN MIND KEY POINTS 4-7 |
| 5. TEST ENGINE OPERATION | 1. SET PARK BRAKE<br>2. PLACE TRANSMISSION IN NEUTRAL<br>3. START ENGINE<br>4. IDLE ENGINE<br>5. INCREASE ENGINE TO MEDIUM SPEED<br>6. IS OPERATION SMOOTH? |
| 6. CLEAN WORK STATION | 1. AS IN PRECEDING TESTS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM JOB UNDER CLOSE SUPERVISION.
2. FURNISH STUDENTS WITH JOB AND TASK SHEETS.
3. RETEACH IF THE NEED ARISES.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN.

USE PERFORMANCE TEST.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY, WARN STUDENTS ABOUT ELECTRONIC IGNITION AND TEST PLUG WIRES BY REMOVING THEM WHILE THE ENGINE IS RUNNING.
2. CAUTION STUDENTS TO EXERCISE CAUTION WHEN HANDLING RESISTANCE CABLES FOR FEAR OF DAMAGING THE CARBON-LIKE CONDUCTOR.
3. REPEAT STEPS OF STAGE II.
4. ITERATE PERTINENT KEY POINTS.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 301-311
AUTO SERVICE AND REPAIR, PP. 21-11 TO 21-16
AUTOMOTIVE ENCYCLOPEDIA, PP. 402-403, 406-412

AUTOMOTIVE MECHANICS, PP. 364-365

THE NEXT LESSON IS: VIII-B-2(S), "REMOVE AND REPLACE IGNITION BREAKER POINTS AND CONDENSER"

THE NEXT LESSON IN THIS SERIES IS: VIII-C-8(S), "DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR"

VIII-C-5(J)

# JOB SHEET
# IN
# IGNITION SYSTEM

**JOB:** REMOVE AND REPLACE SECONDARY IGNITION WIRING

**MATERIALS:** SET OF IGNITION WIRES, CLEAN RAGS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROP LIGHT, SPARK PLUG TERMINAL PLIERS, OHMMETER

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCES. STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE OPERATING TEST EQUIPMENT OR VEHICLE.

| | | |
|---|---|---|
| **PROCEDURE AND/OR TASK:** | VIII-C-5(TS) | REMOVE SECONDARY WIRING |
| | VIII-C-5a(TS) | RESISTANCE TEST SECONDARY WIRING |
| | VIII-C-5b(TS) | INSTALL SECONDARY WIRING |

TASK SHEET VIII-C-5(TS)

**TASK:** REMOVE SECONDARY WIRING

**JOB:** REMOVE AND REPLACE SECONDARY IGNITION WIRING

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SPARK PLUG TERMINAL PLIERS, FENDER COVERS, SEAT COVER, DROP LIGHT, CLEAN RAGS, OHMMETER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. CLEAN WIRES | 1. USE CLEAN RAG<br>2. WIPE THE WIRES AND BOOTS CLEAN OF DIRT, OIL, AND GREASE<br>NOTE: TAKE CARE NOT TO ALLOW DIRT AND FOREIGN MATERIAL TO FALL DOWN AROUND SPARK PLUG |
| 4. PREPARE TO REMOVE WIRES | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR ENGINE FIRING ORDER<br>2. MARK DISTRIBUTOR CAP TOWERS WITH FIRING ORDER MOVING FROM NUMBER ONE WIRE AROUND DISTRIBUTOR CAP<br>3. NOTE WIRING ARRANGEMENT FROM THE DISTRIBUTOR CAP TO EACH SPARK PLUG IN ORDER TO REPLACE WIRES THE SAME WAY<br>4. NOTE POSITION OF WIRES THROUGH CONDUIT OR SUPPORT BRACKET |
| 5. REMOVE WIRES | 1. USE SPARK PLUG TERMINAL PLIERS<br>2. GRASP BOOT ON SPARK PLUG END OF WIRE<br>3. TWIST WIRE BACK AND FORTH<br>4. PULL WIRE FROM SPARK PLUG<br>5. REMOVE WIRES FROM DISTRIBUTOR CAP AS IN KEY POINTS 2-5<br>6. REMOVE SECONDARY WIRE FROM COIL TO DISTRIBUTOR<br>7. DISCARD OLD WIRES |

TASK SHEET VIII-C-5a(TS)

TASK: RESISTANCE TEST SECONDARY WIRING

JOB: REMOVE AND REPLACE SECONDARY IGNITION WIRING

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: OHMMETER, SET NEW SECONDARY WIRES

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PRELIMARY PREPARATIONS | 1. SELECT REPLACEMENT WIRING<br>2. CHECK MANUFACTURER'S SPECIFICATIONS FOR:<br>a. PROPER REPLACEMENT WIRES<br>b. RESISTANCE PER FOOT<br>NOTE: GENERAL RESISTANCE VALUE OF RESISTANCE SECONDARY WIRING IS 8,000 OHMS PER FOOT |
| 2. TEST WIRES FOR RESISTANCE | 1. LAY OUT WIRES<br>2. SET UP OHMMETER AND PLUG INTO POWER SOURCE<br>3. WIPE OHMMETER PROBES CLEAN WITH CLEAN RAG<br>4. TOUCH SECONDARY WIRING CONDUCTOR WITH ONE METER PROBE EACH END<br>5. NOTE OHMMETER READING<br>6. CHECK OHMMETER READING AGAINST MANUFACTURER'S SPECIFICATIONS<br>CAUTION: THE ELECTRONIC IGNITION SYSTEM SECONDARY WIRING IS NOT TO BE TESTED BY PULLING WIRE FROM SPARK PLUG WHILE ENGINE IS RUNNING BECAUSE OF EXCESSIVELY HIGH VOLTAGE |

TASK SHEET VIII-C-5b(TS)

**TASK:** INSTALL SECONDARY WIRING

**JOB:** REMOVE AND REPLACE SECONDARY IGNITION WIRING

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SECONDARY IGNITION WIRING

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. INSTALL WIRES IN DISTRIBUTOR | 1. LAY OUT WIRES ACCORDING TO LENGTH FOR EACH CYLINDER<br>2. NOTE FIRING ORDER AS CODED ON THE DISTRIBUTOR CYLINDER WIRE TOWER<br>3. SELECT NUMBER ONE CYLINDER SECONDARY WIRE<br>4. GRASP BOOT ON DISTRIBUTOR END OF WIRE<br>5. FIRMLY PRESS WIRE INTO NUMBER ONE CYLINDER TOWER OF DISTRIBUTOR<br>6. MAKE SURE BOOT IS WELL DOWN OVER TOWER<br>7. FOLLOWING FIRING ORDER, INSTALL REMAINING WIRES |
| 2. INSTALL WIRES IN CONDUIT OR SUPPORT BRACKET | 1. ARRANGE WIRES FROM DISTRIBUTOR TO SPARK PLUGS IN AN ORDER RECOMMENDED BY MANUFACTURER TO PREVENT CROSSFIRING<br>2. PLACE WIRES THROUGH CONDUIT AS IN SUPPORT BRACKET<br>NOTE: IN CASES WHERE TWO ADJACENT SPARK PLUGS FIRE IN SUCCESSION BE SURE TO SEPARATE THESE TWO WIRES WITH A THIRD WIRE IN THE CONDUCTOR OR SUPPORT BRACKET |
| 3. INSTALL WIRES ON SPARK PLUG | 1. GRASP BOOT ON SPARK PLUG END OF WIRE<br>2. FIRMLY PRESS TERMINAL DOWN OVER TERMINAL END OF SPARK PLUG<br>3. MAKE SURE BOOT IS WELL DOWN OVER SPARK PLUG |

| STEPS | KEY POINTS |
|---|---|
| 4. TEST ENGINE OPERATION | 1. SET PARK BRAKE<br>2. PLACE TRANSMISSION IN NEUTRAL<br>3. START ENGINE<br>4. IDLE ENGINE AND CHECK FOR SMOOTH OPERATION<br>5. INCREASE ENGINE RPM TO MEDIUM SPEED AND CHECK FOR SMOOTH OPERATION<br>6. STOP ENGINE |
| 5. CLEAN WORK STATION | 1. AS IN PRECEDING TASKS |

VIII-C-14(I)

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

**SUBJECT:** IGNITION RESISTOR AND BYPASS

**AIM:** THE STUDENT WILL BE ABLE TO STATE THE PURPOSE AND FUNCTION OF BALLAST RESISTORS AND BYPASS CIRCUITS, AND IDENTIFY THE DIFFERENT TYPES.

**TEACHING AIDS:** FLIP CHART: THE IGNITION CIRCUIT, TECHNICAL LITERATURE DEPARTMENT, DELCO-REMY DIVISION, GENERAL MOTORS CORP, ANDERSON, IN 46011
TRANSPARENCIES, I. ED. II. 7T, FIGS. 309-310

**MATERIALS:** USED BALLAST RESISTORS OF VARIOUS TYPES

**REFERENCES:**
AUTOMECHANICS, GLENN, PP. 283
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 422-423
AUTO SERVICE AND REPAIR, STOCKEL, PP. 21-3, 21-4
AUTOMOTIVE MECHANICS, CROUSE, CH. 15

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REQUIRED REFERENCES FOR THIS LESSON.

---

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WE HAVE LEARNED THAT IN ORDER TO PERFORM EFFICIENTLY UNDER ALL KINDS OF CONDITIONS, THE IGNITION SYSTEM MUST BALANCE OUT. THE REQUIREMENTS FOR STARTING A COLD ENGINE ARE A LOT DIFFERENT FROM THOSE NECESSARY FOR OPERATING ONE THAT IS WARMED UP AND RUNNING. TWO OF THE DEVICES THAT HELP MEET THESE DIFFERENT REQUIREMENTS ARE WHAT WE WILL LEARN ABOUT TODAY: THE BALLAST RESISTOR AND BYPASS CIRCUIT.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PRIMARY CIRCUIT OPERATION | 1. CIRCUIT BEGINS AT "HOT POST" OF BATTERY |
| | 2. GOES TO THE STARTER SOLENOID OR IGNITION SWITCH |
| | 3. THROUGH BALLAST RESISTOR TO COIL PRIMARY |

4. FROM COIL PRIMARY TO DISTRIBUTOR POINTS
5. WHEN POINTS CLOSE CURRENT GOES TO GROUND
6. TRAVELS BACK TO GROUND SIDE OF BATTERY

B. PURPOSE OF RESISTOR

1. LIMITS BATTERY VOLTAGE TO COIL
2. PROTECTS COIL FROM PRIMARY CURRENT BUILD UP WHEN IGNITION IS ON AND ENGINE IS NOT RUNNING
3. HELPS KEEP COIL COOLER IN OPERATION
4. PROTECTS THE POINTS AT LOW SPEED WHEN CLOSED LONGER

C. BYPASS CIRCUITS

1. RESISTANCE BYPASSED BY STARTING MOTOR SOLENOID SWITCH CONNECTED TO COIL IN SOME VEHICLES
2. MAY BE BYPASSED BY STARTER TERMINAL ON IGNITION SWITCH
3. LACK OF HEAT ACTS AS BYPASS ON SOME
4. BYPASS CIRCUITS DELIVER FULL BATTERY VOLTAGE TO COIL AND STARTER FOR CRANKING EFFICIENCY AT LOW TEMPERATURE

D. TYPES OF RESISTORS

1. SOME VEHICLES HAVE SEPARATELY MOUNTED BALLAST RESISTOR
2. RESISTOR IN WIRING HARNESS OF MOST CARS
3. TYPES OF RESISTANCE WIRE
   a. CALIBRATED RESISTANCE WIRE COMPOSED OF CARBON IMPREGNATED FIBER GLASS
   b. SPECIAL METAL ALLOY
   c. STAINLESS STEEL
4. TEMPERATURE SENSITIVE RESISTORS RELAY MORE CURRENT WHEN COLD BUT HEAT RAISES RESISTANCE

E. RESISTOR TESTS

1. RESISTOR SHOULD OFFER SPECIFIC AMOUNT OF RESISTANCE-CHECK SPECIFICATIONS

2. VOLTMETER TEST CONNECTIONS
   a. NEGATIVE VOLTMETER LEAD TO COIL PRIMARY "B" TERMINAL
   POSITIVE LEAD TO ACCESSORY TERMINAL OF IGNITION SWITCH
   c. JUMPER WIRE FROM COIL PRIMARY "D" TERMINAL TO DISTRIBUTOR GROUND

SHOW: TRANSPARENCY
FIG. 310

3. IGNITION SWITCH SHOULD BE ON-LIGHTS AND ACCESSORIES OFF
4. THE METER READING OVER 6.6 VOLTS INDICATES BAD RESISTOR
5. OHMMETER CAN BE USED TO TEST RESISTOR ALSO

CAUTION: DISCONNECT WIRE BETWEEN IGNTION SWITCH AND RESISTOR TO PREVENT OHMMETER DAMAGE

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENT, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT IS USUALLY CUT OUT, OR BYPASSED, IN THE PRIMARY CIRCUIT WHEN AN ENGINE IS CRANKED?

ANSWER: THE BALLAST RESISTOR

2. WHAT TWO COMPONENTS DOES THE RESISTOR PROTECT?

ANSWER: THE COIL AND BREAKER POINTS

3. NAME THE CIRCUIT THAT ELIMINATES THE RESISTOR IN STARTING.

ANSWER: BYPASS CIRCUIT

4. NAME THE TWO INSTRUMENTS USED TO TEST RESISTORS.

ANSWER: VOLTMETER AND OHMMETER

5. WHERE WILL WE FIND THE RESISTOR IN MOST CARS?

ANSWER: IN THE WIRING HARNESS.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED.)

TRUE - FALSE TEST

1. THE PRIMARY CIRCUIT BEGINS AND ENDS IN THE BATTERY. T

## IV. VERIFICATION (CON'T.)

| | | |
|---|---|---|
| 2. | WHEN BREAKER POINTS OPEN THE PRIMARY CURRENT GOES TO GROUND. | F |
| 3. | A COIL NEEDS MORE PROTECTION AT LOW ENGINE SPEED. | T |
| 4. | HEAT LOWERS RESISTANCE OF A WIRE. | F |
| 5. | STAINLESS STEEL IS USED IN SOME RESISTORS. | T |
| 6. | SPECIFICATIONS FOR RESISTANCE VARY WITH DESIGNERS. | T |
| 7. | SOME BALLAST RESISTORS ARE MORE EASILY FOUND THAN OTHERS. | T |
| 8. | AN AMMETER IS A TEST DEVICE FOR RESISTORS. | F |
| 9. | A VOLTMETER GIVES A READING IN OHMS. | F |
| 10. | VOLTMETER LEADS ARE CONNECTED TO THE COIL PRIMARY IN TESTING RESISTORS. | T |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. CURRENT FLOWS IN THE PRIMARY CIRCUIT FROM BATTERY TO STARTER OR IGNITION SWITCH TO RESISTOR TO COIL TO DISTRIBUTOR POINTS TO GROUND AND BACK TO BATTERY.
2. PRIMARY FUNCTION OF THE BALLAST RESISTOR IS PROTECTING THE COIL AND BREAKER POINTS FROM TOO MUCH CURRENT.
3. THERE ARE SEVERAL TYPES OF BYPASS CIRCUITS USED TO DELIVER FULL BATTERY CURRENT TO THE COIL AND STARTING MOTOR DURING CRANKING.
4. BALLAST RESISTORS ARE SOMETIMES A SEPARATE UNIT BUT MORE FREQUENTLY ARE COMPOSED OF SPECIAL MATERIAL INCORPORATED INTO THE WIRING HARNESS.
5. TWO INSTRUMENTS ARE USUALLY USED TO TEST RESISTORS. THEY ARE THE VOLTMETER AND OHMMETER.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CH. 16

THE NEXT LESSON IS: VIII-C-15(I), "DISTRIBUTOR COMPONENTS"

VIII-C-15(I)

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

**SUBJECT:** DISTRIBUTOR COMPONENTS

**AIM:** THE STUDENT WILL BE ABLE TO NAME THE PARTS OF VARIOUS TYPES OF DISTRIBUTORS AND IDENTIFY THEIR FUNCTIONS IN RELATION TO EMISSION CONTROL AND IGNITION CIRCUITRY.

**TEACHING AIDS:** FLIP CHARTS: FUNDAMENTALS OF ELECTRICITY AND MAGNETISM AND THE IGNITION CIRCUIT, DELCO-REMY DIV. GENERAL MOTORS
TRANSPARENCIES I. ED. II 7T, FIGS. 314-316, 330-342
CHALKBOARD

**MATERIALS:** CHALK

**REFERENCES:** AUTOMECHANICS, GLENN, CH. 10
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 395-400
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21
AUTOMOTIVE MECHANICS, CROUSE, CH. 15 AND 25

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REFERENCES FOR THIS LESSON.

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

UP TO THIS POINT WE HAVE DISCUSSED SECONDARY WIRING, SECONDARY VOLTAGE, AND SPARK PLUGS WHERE THE VOLTAGE DOES ITS WORK. NOW WE NEED TO LOOK AT THE UNIT RESPONSIBLE FOR DELIVERY - THE DISTRIBUTOR. SINCE IT IS A VERY IMPORTANT COMPONENT, WE NEED TO KNOW MORE ABOUT ITS PARTS, HOW THEY WORK, AND ABOUT SOME RECENT MODIFICATIONS IN IGNITION DISTRIBUTION.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. FUNCTIONS OF THE DISTRIBUTOR | 1. BREAKS FLOW OF CURRENT THROUGH LOW VOLTAGE PRIMARY CIRCUIT OF COIL<br>a. SUDDEN STOP OF CURRENT CAUSES SURGE OF ELECTRONS TOWARD COIL CORE<br>b. SURGE PAST SECONDARY COIL WIRING BUILDS UP THOUSANDS OF |

VOLTS IN SECONDARY CIRCUIT

2. TIMES VOLTAGE SURGES WITH ENGINE REQUIREMENTS BASED ON LOAD AND SPEED CONDITIONS
3. DISTRIBUTES HIGH VOLTAGE TO SPARK PLUG OF CYLINDER READY TO FIRE
4. CLOSES PRIMARY CIRCUIT AND ALLOWS IT TO BUILD UP AGAIN

B. CONVENTIONAL DISTRIBUTOR COMPONENTS

SHOW: TRANSPARENCIES FIGS. 314-316

1. CAP - PROVIDES ATTACHMENTS AND INTERNAL POSTS FOR SPARK PLUG WIRES AND RECEIVES HIGH VOLTAGE FROM COIL SECONDARY CIRCUIT
2. ROTOR - ROTATES ON DISTRIBUTOR SHAFT AND DISPENSES SURGES OF CURRENT TO SPARK PLUG WIRE TERMINAL
3. BREAKER POINT SET - PROVIDES THE GROUND FOR PRIMARY CIRCUIT IN CLOSED POSITION AND BREAKS THE CIRCUIT WHEN OPENED
4. CONDENSER - AIDS BREAKER POINTS IN BREAKING PRIMARY CIRCUIT BY ABSORBING CURRENT OVERFLOW
5. BREAKER PLATE - SUPPORTS BREAKER POINTS AND CONDENSER
6. CAM - PART OF DISTRIBUTOR DRIVE SHAFT THAT OPERATES POINT SETS
7. CENTRIFUGAL ADVANCE MECHANISM LEVERS, WEIGHTS, AND SPRING ARRANGEMENT THAT ADJUSTS BREAKER POINT OPERATION TO ENGINE SPEED
8. VACUUM ADVANCE UNIT - ADJUSTS THE BREAKER POINT TIMING TO ENGINE LOAD AND SPEED REQUIREMENTS ACCORDING TO INTAKE MANIFOLD VACUUM
9. DISTRIBUTOR HOUSING - SUPPORTS AND PROTECTS PARTS AND ALLOWS FOR IGNITION TIMING ADJUSTMENT BY ROTATING ITS POSITION
10. DRIVE SHAFT - OPERATES DISTRIBUTOR CAM, ROTOR, AND OIL PUMP

C. DISTRIBUTOR DRIVE (GEAR DRIVE)

1. DISTRIBUTOR SHAFT DRIVEN BY ENGINE CAMSHAFT

- a. ROTATING SPIRAL GEAR ON CAMSHAFT
- b. TURNS GEAR TWICE ITS SIZE ON DISTRIBUTOR SHAFT
- c. RESULTS IN DISTRIBUTOR SHAFT ROTATING AT ONE-HALF CAMSHAFT SPEED

2. ALLOWS PLUGS TO FIRE ON ONLY POWER STROKE OF PISTON
3. DISTRUBTOR SHAFT COUPLED TO AND DRIVES THE OIL PUMP

NOTE: GEARS MUST MESH PROPERLY SO LOCATION OF GEAR ON SHAFT IS CRITICAL

2. LUG AND SLOT DRIVE

1. LUG OR TANG OF DISTRIBUTOR SHAFT FITS SLOT IN OIL PUMP GEAR
2. OPERATION BASICALLY SAME AS GEAR DRIVE
3. SHAFT MIGHT ROTATE IN EIGHER DIRECTION

D. TIMING ADJUSTMENT

1. ROTATING THE DISTRIBUTOR HOUSING CHANGES TIMING OF IGNITION
   - a. ADVANCED TIMING CAUSES SPARK TO OCCUR EARLIER IN THE POWER STROKE
   - b. RETARDED TIMING CAUSES SPARK TO OCCUR LATER IN STROKE
2. ROTATING BREAKER PLATE ALSO CHANGES ENGINE TIMING

E. TRANSISTORIZED IGNITION

1. FOUND IN LATER MODEL VEHICLES
2. HAS SOME PARTS THAT MAY BE SAME AS CONVENTIONAL DISTRIBUTOR
   - a. HOUSING AND ADVANCE MECHANISM
   - b. ROTOR, DRIVE, AND CAP

SHOW: TRANSPARENCIES FIGS. 330-342

3. OTHER PARTS ARE DIFFERENT
   - a. PICK-UP UNIT CONSISTS OF:
     - (1) PERMANENT MAGNET
     - (2) COIL
     - (3) POLE PIECE
   - b. THIRD ELECTRICAL CIRCUIT USED TO SIGNAL CONTROL UNIT
   - c. RELUCTOR TEETH CAUSE INDUCED VOLTAGE IN PICK-UP COIL

d. PICK-UP UNIT AND RELUCTOR DETERMINE IGNITION TIMING

e. ELECTRONIC CONTROL UNIT
   (1) CAUSES COLLAPSE OF PRIMARY CIRCUIT IN IGNITION COIL
   (2) DETERMINES THE DWELL OR CLOSED TIME OF PRIMARY CIRCUIT
   (3) DWELL REMAINS SAME UNLESS THIS UNIT IS DAMAGED

f. DUAL BALLAST RESISTOR
   (1) HALF OHM SIDE OF RESISTOR PROTECTS IGNITION COIL
   (2) FIVE OHM SIDE PROTECTS THE CONTROL UNIT

F. EMISSION CONTROL

1. HIGHER COMPRESSION RATIO OF MODERN ENGINES REQUIRES DEVICES TO REDUCE HYDROCARBONS
2. MAY CAUSE HIGHER OPERATING TEMPERATURES IN ENGINE THUS MORE THOROUGH COMBUSTION
3. ALTERED IGNITION TIMING IS WIDELY USED
   a. MODIFIED DISTRIBUTORS AFFECT ADVANCE CURVE
   b. SPARK RETARDED AT IDLE SPEED
   c. ADDITIONAL SPARK ADVANCE IN DECELERATION

G. PRIMARY CIRCUIT PARTS AND FUNCTION

1. BATTERY - STORES ENERGY NEEDED FOR STARTING
2. BALLAST RESISTOR - PROTECTS COIL
3. IGNITION SWITCH - DELIVERS LOW VOLTAGE TO COIL PRIMARY
4. COIL - TRANSFORMS BATTERY VOLTAGE TO MANY THOUSANDS IN THE SECONDARY CIRCUIT
5. BREAKER POINTS AND CONDENSER CLOSE AND OPEN PRIMARY CIRCUIT
6. WIRING OF PRIMARY CIRCUIT IS SMALL IN SIZE AND THINLY INSULATED DUE TO LOW VOLTAGE IT HANDLES

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT ARE THE FUNCTIONS OF AN IGNITION DISTRIBUTOR?

ANSWER: IT OPENS AND CLOSES THE PRIMARY CIRCUIT, TIMES THE ENERGY SURGES, AND DELIVERS HIGH VOLTAGE TO SPARK PLUGS.

2. WHICH DISTRIBUTOR PARTS BREAK THE PRIMARY CIRCUIT?

ANSWER: BREAKER POINTS AIDED BY THE CONDENSER

3. NAME THE MECHANISMS THAT AUTOMATICALLY ADJUST TIMING.

ANSWER: CENTRIFUGAL ADVANCE AND VACUUM ADVANCE UNITS

4. WHAT ARE THE TWO TYPES OF DISTRIBUTOR DRIVE?

ANSWER: GEAR DRIVE AND LUG AND SLOT DRIVE

5. NAME THE PARTS OF A TRANSISTORIZED IGNITION THAT DETERMINE TIMING.

ANSWER: PICK-UP UNIT AND RELUCTOR

6. WHICH PART OF A TRANSISTORIZED SYSTEM DETERMINES DWELL?

ANSWER: CONTROL UNIT

7. HOW IS A DISTRIBUTOR USED TO REDUCE EXHAUST EMISSION?

ANSWER: BY RETARDING OR ADVANCING TIMING FOR MORE COMPLETE FUEL COMBUSTION

8. THE BREAKER POINTS AND CONDENSER ARE PARTS OF WHICH CIRCUIT?

ANSWER: PRIMARY CIRCUIT

9. DESCRIBE THE PRIMARY CIRCUIT WIRING.

ANSWER: SMALL AND THINLY INSULATED

10. WHAT PART OF THE SYSTEM ACTS AS A TRANSFORMER?

ANSWER: IGNITION COIL

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

1. THE DISTRIBUTOR OPENS AND CLOSES THE PRIMARY CIRCUIT BETWEEN ____ AND ____. COIL GROUND

2. THE ____ DISPENSES SURGES OF CURRENT TO SPARK PLUG WIRE TERMINALS IN THE DISTRIBUTOR CAP. ROTOR

## IV. VERIFICATION (CON'T.)

| | |
|---|---|
| 3. A _____ OPERATES THE BREAKER POINTS. | CAM |
| 4. A ROTOR FITS ON TOP OF THE _____. | DISTRIBUTOR SHAFT |
| 5. A PERMANENT MAGNET IS PART OF THE _____ UNIT IN A TRANSISTORIZED IGNITION. | PICK-UP |
| 6. IN A TRANSISTORIZED SYSTEM, A PICK-UP UNIT AND _____ DETERMINE IGNITION TIMING. | RELUCTOR |
| 7. A DISTRIBUTOR SHAFT IS USUALLY DRIVEN BY THE ENGINE _____. | CAMSHAFT |
| 8. FOR BETTER EMISSION CONTROL A DISTRIBUTOR _____ TIMING AT IDLE AND _____ TIMING IN DECELERATION. | RETARDS<br>ADVANCES |
| 9. BREAKER POINTS AND IGNITION SWITCH ARE PARTS OF THE _____ CIRCUIT. | PRIMARY |
| 10. THOUSANDS OF VOLTS ARE DEVELOPED IN THE COIL _____ CIRCUIT. | SECONDARY |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

A DISTRIBUTOR IS RESPONSIBLE FOR OPERATING THE PRIMARY CIRCUIT, TIMING THE ENERGY SURGES, AND DELIVERING HIGH VOLTAGE AT THE PROPER TIME AND PLACE.

AS THE ONLY UNIT OF THE SECONDARY CIRCUIT WITH MECHANICAL MOVEMENT, THE DISTRIBUTOR HAS MANY PARTS, BUT ALL ARE RELATIVELY SIMPLE IN DESIGN AND OPERATION.

TRANSISTORIZED IGNITION SYSTEMS ARE RECENT INNOVATIONS THAT APPEAR MORE EFFICIENT IN OPERATION YET REQUIRE LESS SERVICING THAN CONVENTIONAL SYSTEMS.

DISTRIBUTOR DRIVES VARY IN DESIGN BUT ALL ARE DRIVEN DIRECTLY OR INDIRECTLY BY THE CAMSHAFT.

THE PRIMARY CIRCUIT OPERATES ON BATTERY VOLTAGE, AND THE DISTRIBUTOR PLAYS AN IMPORTANT PART IN JUMPING IT UP TO 20,000 OR MORE IN THE SECONDARY CIRCUIT.

SUGGESTED READING FOR THE STUDENT:

AUTO SERVICE AND REPAIR, STOCKEL, CH. 21

THE NEXT LESSON IS: VIII-C-16(I), "IGNITION DISTRIBUTOR"

VIII-C-16 (I)

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

**SUBJECT:** IGNITION DISTRIBUTOR

**AIM:** THE STUDENT WILL BE ABLE TO EXPLAIN THE PRINCIPLES OF IGNITION DISTRIBUTION, ITS TIMING, AND ADJUSTMENT. HE WILL BE ABLE TO IDENTIFY VARIOUS TYPES OF DISTRIBUTORS AND COMPARE SOME ADVANTAGES OF EACH.

**TEACHING AIDS:** FLIP CHARTS: FUNDAMENTALS OF ELECTRICITY AND MAGNETISM AND THE IGNITION CIRCUIT, TECHNICAL SECTION, DELCO-REMY DIVISION, GENERAL MOTORS, ANDERSON, IN. 46011
TRANSPARENCIES: I. ED. II 7T, FIGS. 320-341

**REFERENCES:** AUTOMOTIVE MECHANICS, CROUSE, CH. 15 AND 25
AUTOMECHANICS, GLENN, CH. 10
AUTO SERVICE AND REPAIR, STOCKEL, CH. 21
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 387-404

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE READ THE REFERENCES FOR THE LESSON

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN THE LAST LESSON WE TALKED ABOUT THE VARIOUS TYPES OF DISTRIBUTORS, THEIR COMPONENTS, AND THEIR FUNCTION IN BREAKING DOWN THE PRIMARY CIRCUIT TO PRODUCE A SPARK. BUT WE HAVE NOT LEARNED HOW THE SPARK HAPPENS TO BE AT THE RIGHT PLACE AT EXACTLY THE RIGHT TIME. THESE ARE THE CONSIDERATIONS WE WILL TAKE UP TODAY.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. IGNITION SPECIFICATIONS | 1. IGNITION SYSTEMS DESIGNED TO BALANCE<br>2. SPECIFICATIONS DIFFER WITH ENGINES<br>3. THE MANUFACTURER'S SHOP MANUAL GIVES SPECIFICATIONS<br>4. VARIANCE BETWEEN ACTUAL AND THE MANUFACTURER'S SPECIFICATIONS GIVES CLUE TO PROBLEMS |

| | |
|---|---|
| 1. DISTRIBUTOR | 1. "SPECS" BASED ON THE NORMAL OR AVERAGE CONDITIONS<br>2. AVERAGE SPECIFICATIONS OF DISTRIBUTORS AND COMPONENTS:<br>a. CONTACT POINT SPRING TENSION 17 TO 20 OUNCES<br>b. CONTACT POINT GAP .020<br>c. THE TIMING SET TO FIRE AT EACH PLUG AT:<br>(1) 8 DEGREES BEFORE TOP DEAD CENTER AT 1,000 RPM<br>(2) 26 DEGREES BEFORE TOP DEAD CENTER AT 2,000 RPM<br>d. DWELL 34 TO 38 DEGREES FOR 6 CYLINDER AND 26 TO 32 DEGREES FOR 8 CYLINDER |
| 2. IDLE SPECIFICATIONS | 1. 450 TO 500 RPM IN CAR WITH MANUAL TRANSMISSION<br>2. AUTOMATIC TRANSMISSIONS DIFFER WITH VARIOUS MAKE VEHICLES<br>NOTE: USE MANUFACTURERS' SPECS<br>3. TIMING ADJUSTED AT IDLE OR FAST IDLE |
| B. DWELL | |
| 1. DWELL ANGLE | 1. DWELL IS PERIOD OF CONTACT POINT CLOSED TIME<br>2. SAME THROUGHOUT SPEED RANGE<br>3. VARIANCE OF 3 DEGREES OR LESS ON MOST CARS<br>4. STATIONARY BREAKER POINT MOVED TO ADJUST DWELL<br>5. LATER MODELS HAVE ADJUSTMENT SCREWS |
| 2. DWELL METER | 1. DWELL MEASURED WITH CAM ANGLE OR DWELL METER<br>2. CONNECTS TO DISTRIBUTOR SIDE OF COIL<br>3. IS ACTUATED BY PRIMARY CIRCUIT<br>4. SCALE CALIBRATED 0 TO 50 DEGREES<br>5. MEASURES IMPULSE DURATION FROM DISTRIBUTOR |

| | |
|---|---|
| C. TIMING LIGHT<br>SHOW: TRANSPARENCIES FIGS. 328-331 | 1. COMPARES SPARK IN RELATION TO POSITION OF PISTON<br>2. TIMING MARKS USUALLY ON FRONT OF ENGINE<br>3. FLASH CORRESPONDS WITH SPARK IN NO. 1 CYLINDER<br>4. MARKS APPEAR STATIONARY DUE TO SYNCHRONIZATION<br>5. LINES SHIFT AS SPEED INCREASES<br>6. CHECKS TIMING AND SPARK ADVANCE MECHANISMS |
| D. DISTRIBUTOR ADVANCE MECHANISMS<br>SHOW: TRANSPARENCIES FIGS. 334-335 | 1. TIMING REQUIREMENTS VARY WITH SPEED AND LOAD<br>2. VACUUM ADVANCE MECHANISM<br>3. CENTRIFUGAL ADVANCE MECHANISM<br>4. MOST DISTRIBUTORS HAVE BOTH<br>5. FUNCTION TO MAKE SPARK OCCUR EARLIER |
| E. PRIMARY RESISTANCE<br>SHOW: TRANSPARENCIES FIGS. 330-342 | 1. CONDUCTORS RESIST THE FLOW OF CURRENT<br>2. LOWER PRIMARY VOLTAGE REQUIRES LESS RESISTANCE<br>3. WIRING USUALLY HAS METAL CONDUCTORS<br>4. BAD WIRE AND LOOSE OR CORRODED TERMINALS RAISE RESISTANCE<br>5. REDUCTION OF CURRENT IN PRIMARY CUTS DOWN SECONDARY VOLTAGE |
| F. TYPES OF DISTRIBUTORS<br>SHOW: TRANSPARENCIES FIGS. 336-339 | 1. VARIATION IN CAP DESIGN<br>2. VARIATION IN TYPE OF DRIVE<br>3. VARIATION IN ADVANCE MECHANISMS<br>4. VARIATION IN INTERNAL PARTS |
| 1. CONVENTIONAL | 1. HAS ONE SET POINTS AND ONE CONDENSER<br>2. FOUND ON MOST ENGINES<br>3. SATISFACTORY FOR NORMAL CONDITIONS |
| 2. DUAL POINT | 1. HAS TWO SETS OF BREAKER POINTS<br>2. ALLOWS MORE CLOSED TIME THUS HOTTER SPARK |

3. USUALLY 8 DEGREES LAG IN OPERATION
4. FOUND ON HIGH SPEED-HIGH PERFORMANCE ENGINES

3. TRANSISTORIZED

1. SOME UTILIZE THREE CIRCUITS
    - a. THE PRIMARY AND SECONDARY CIRCUITS SAME AS CONVENTIONAL
    - b. THIRD CIRCUIT OPERATES PRIMARY CIRCUIT
2. DELIVERS MORE VOLTAGE AT HIGHER SPEEDS
3. FEWER SERVICE REQUIREMENTS

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. HOW CAN A SHOP MANUAL HELP DIAGNOSE IGNITION PROBLEMS?

ANSWER: COMPARING ACTUAL MEASUREMENTS WITH WHAT THE SPECIFICATIONS CALL FOR CAN GIVE CLUES TO THE TROUBLE.

2. HOW DOES RPM AFFECT IGNITION TIMING?

ANSWER: FASTER RPM REQUIRES EARLIER SPARK.

3. WHAT IS THE RELATIONSHIP BETWEEN A CAR'S TRANSMISSION AND ITS IDLE SPECIFICATIONS?

ANSWER: CARS WITH MANUAL TRANSMISSIONS IDLE AT 450 TO 500 RPM AND THOSE WITH AUTOMATIC TRANSMISSIONS VARY.

4. WHAT IS MEANT BY DWELL?

ANSWER: NUMBER OF DEGREES OF CAM ROTATION WHEN CONTACT POINTS ARE CLOSED.

5. NAME TWO KINDS OF SPARK ADVANCE MECHANISMS.

ANSWER: VACUUM AND CENTRIFUGAL

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIAL PRESENTED)

TRUE - FALSE TEST

1. MANUFACTURERS BASE SPECIFICATIONS ON AVERAGE CONDITIONS. T

## IV. VERIFICATION (CON'T.)

2. PISTON POSITION IS IMPORTANT IN IGNITION TIMING. T

3. A DWELL METER IS USED TO TIME AN ENGINE. F

4. A TIMING LIGHT MEASURES THE AMOUNT OF POINT CLOSED TIME. F

5. TIMING MARKS ARE USUALLY NEAR THE FRONT OF AN ENGINE. T

6. A TIMING LIGHT CAN BE USED TO CHECK SPARK ADVANCE MECHANISMS. T

7. MOST DISTRIBUTORS HAVE TWO SPARK ADVANCE DEVICES. T

8. VOLTAGE IS MUCH LOWER IN THE PRIMARY CIRCUIT. T

9. DUAL POINT DISTRIBUTORS HAVE AN OVERLAP IN THE POINTS CLOSED POSITION. T

10. A PROBLEM WITH TRANSISTORIZED DISTRIBUTORS IS THAT THEY REQUIRE SERVICING MORE OFTEN. F

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## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS)

1. KNOWLEDGE OF MANUFACTURER'S SPECIFICATIONS IS HELPFUL AND SOMETIMES NECESSARY IN IGNITION WORK.

2. THERE WILL USUALLY BE ONLY A LITTLE VARIATION FROM THE AVERAGE IN MANY IGNITION SPECIFICATIONS SINCE MANUFACTURERS BASE THEIR "SPECS" ON AVERAGE CONDITIONS.

3. DWELL IS THE PERIOD OF TIME THE POINTS ARE CLOSED AND IS MEASURED WITH A DWELL METER.

4. A TIMING LIGHT GIVES THE RELATIONSHIP BETWEEN POSITION OF NUMBER 1 PISTON AND SPARK.

5. TIMING REQUIREMENTS VARY WITH SPEED AND LOAD AND DISTRIBUTORS HAVE BUILT IN DEVICES TO COMPENSATE FOR THE DIFFERENCES.

6. RESISTANCE TOO HIGH IN THE PRIMARY CIRCUIT CAN REDUCE VOLTAGE AVAILABLE TO THE SECONDARY.

7. THERE ARE THREE BASIC TYPES OF DISTRIBUTORS: THE CONVENTIONAL TYPE USED ON MOST CARS BECAUSE OF ITS CHEAPER PRICE, DUAL POINT DISTRIBUTORS WHICH GIVE BETTER SERVICE AT HIGH SPEEDS, AND TRANSISTORIZED DISTRIBUTORS WHICH ARE MORE EFFICIENT AND REQUIRE LESS SERVICING.

SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, GLENN, CH. 10

THE NEXT LESSON IS: VIII-C-17(I), "DISTRIBUTOR SERVICE"

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | DISTRIBUTOR SERVICE |
| AIM: | THE STUDENT WILL BE ABLE TO DISTINGUISH BETWEEN WORN AND SERVICEABLE DISTRIBUTOR PARTS AND DESCRIBE THE PROCEDURES USED IN DISTRIBUTOR SERVICE AND ADJUSTMENT. |
| TEACHING AIDS: | MANUAL, SUN ELECTRIC CORPORATION, HARLEM AND AVONDALE, CHICAGO, ILL. 60631<br>MANUFACTURERS' SERVICE MANUALS FROM LOCAL DEALERS<br>TRANSPARENCIES I. ED. II 7 T, FIGS. 313-341 |
| MATERIALS: | DAMAGED OR WORN DISTRIBUTOR AND/OR PARTS |
| REFERENCES: | AUTOMECHANICS, GLENN, CH. 10<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 395-400<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 21<br>AUTOMOTIVE MECHANICS, CROUSE, CHS. 15 AND 25 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE SATISFACTORILY COMPLETED THE PRECEDING LESSONS ON THE DISTRIBUTOR AND ITS COMPONENTS. |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN THE LAST FEW LESSONS WE HAVE LEARNED ABOUT THE IGNITION DISTRIBUTOR, ITS COMPONENTS, AND THE THEORY OF HOW IT FUNCTIONS. HOWEVER, BEFORE WE TEAR ONE DOWN TO SERVICE IT, WE NEED TO KNOW WHAT TO LOOK FOR, WHERE PROBLEMS ARE MORE LIKELY TO OCCUR, AND THE PROCEDURES FOR PUTTING IT BACK TOGETHER CORRECTLY.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. DISTRIBUTOR CAP | 1. WIRE TOWERS MAY SHOW CORROSION, BURNING, CARBON TRACKING |
| | 2. INSIDE MAY SHOW FLASHOVER, CRACKING, ROTOR CONTACT BURNS OR CRACKS, TERMINAL BURN OR WEAR |
| | 3. INSULATION QUALITY CHECKED ON HIGH VOLTAGE EQUIPMENT |

B. ROTOR

SHOW: TRANSPARENCIES FIGS. 338-341

1. TIP MAY BE BURNED
2. CONTACT SPRING AND RESISTANCE ROD CHECK
3. ROTOR REPLACED WHEN CAP REPLACED

CAUTION: CARELESS INSTALLATION OF ROTOR CAN DAMAGE CAP, ROTOR, OR BOTH

C. BREAKER POINTS

SHOW: TRANSPARENCIES FIGS. 316-327

1. CONTACTS BADLY PITTED, ERODED, BURNED, ETC. SHOULD BE REPLACED
2. THE POINTS NOT BADLY WORN MAY BE DRESSED AND REUSED
3. RUBBING BLOCK MAY SHOW EXCESSIVE WEAR FROM:
   a. EXCESSIVE SPRING TENSION
   b. LACK OF CAM LUBRICANT
   c. ROUGH CAM SURFACE
4. BREAKER POINT GAP
   a. TOO LITTLE CAUSES ARCING AND BURNING
   b. TOO MUCH REDUCES DWELL CAUSING HIGH SPEED MISS
5. DWELL METER BEST FOR SETTING WORN POINTS
6. BREAKER ARM TENSION
   a. TOO MUCH CAUSES RUBBING BLOCK WEAR
   b. TOO LITTLE CAUSES FLOATING OR BOUNCING
   c. SHOULD BE ADJUSTED TO SPECIFICATIONS

D. CONDENSER

SHOW: TRANSPARENCIES FIGS. 313-316

1. USUALLY REPLACED WITH POINTS
2. CHECKED FOR LEAKAGE, RESISTANCE, AND CAPACITY
3. THE WRONG CAPACITY CAUSES METAL TRANSFER AT POINTS

E. WIRES AND CONNECTIONS

1. INSULATION IS IMPORTANT
2. CONNECTIONS CLEAN AND FIRMLY ATTACHED
3. WIRES OUT OF WAY OF MOVING PARTS

F. DISTRIBUTOR CAM

1. MAY HAVE LUBRICATING WICK
2. CAM MAY NEED CLEANING
3. THIN COATING HIGH TEMPERATURE GREASE IF NOT OTHERWISE LUBRICATED
4. DRY LUBRICATING WICK SHOULD BE REPLACED

CAUTION: DO NOT LUBRICATE WITH OIL OR LOW TEMPERATURE GREASE

G. LUBRICATION POINTS

1. LIFT - OFF ROTOR MAY HAVE FELT WICK OILER UNDERNEATH
2. PIVOT PIN AND BUSHING OF BREAKER ARM
3. BUSHING OILER RESERVOIRS
4. CENTRIFUGAL ADVANCE UNIT
5. BREAKER PLATE BEARINGS

CAUTION: THREE TO FIVE DROPS SUFFICIENT, DO NOT OVER OIL

H. CENTRIFUGAL ADVANCE UNIT

1. MAY BECOME GUMMY OR CORRODED THUS TOO SLOW IN OPERATION
2. STRETCHED OUT OR BROKEN RETURN SPRINGS MUST BE REPLACED
3. MOST HAVE ADJUSTMENT POSTS

USE: TRANSPARENCY
FIG. 334

I. VACUUM ADVANCE UNIT

1. SOME ARE NOT ADJUSTABLE
2. WASHERS MAY VARY SPRING TENSION ON SOME
3. LEAKS IN LINE OR BROKEN DIAPHRAGM REDUCE EFFICIENCY

USE: TRANSPARENCY
FIG. 335

J. DISTRIBUTOR OVERHAUL

1. NECESSARY WHEN EXCESSIVE WEAR IN GEAR, BUSHINGS, CAM, SHAFT, ADVANCE UNITS, ETC.
2. GEAR OCCUPIES EXACT LOCATION ON SHAFT
3. ALL PARTS THOROUGHLY CHECKED, CLEANED, OILED, OR REPLACED AS NECESSARY
4. AFTER REASSEMBLY, DISTRIBUTOR SHOULD BE BENCH TESTED

CAUTION: GEAR PIN SHOULD BE COMPLETELY THROUGH AND WELL PEENED

K. DISTRIBUTOR INSTALLATION

1. EASIER TO ACCOMPLISH IF MARKED FOR POSITION BEFORE REMOVAL
2. GEARS MUST MESH WITH ROTOR IN PROPER POSITION
3. SHAFT AND OIL PUMP TANG MUST MATCH

CAUTION: DO NOT FORCE DISTRIBUTOR DOWN WITH HOLDING DOWN CLAMP

L. DISTRIBUTOR TIMING

1. DISTRIBUTOR MUST BE TIMED AFTER INSTALLATION
2. POINT GAP MUST BE SET BEFORE TIMING IGNITION
3. INITIAL SETTING TO START ENGINE
    a. POINTER OR SCALE AND TIMING MARKS ALIGNED
    b. ROTOR POINTING TO NUMBER ONE TOWER
    c. POINTS IN JUST OPENING POSITION
4. TIME ENGINE TO MANUFACTURER'S SPECIFICATIONS

---

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENT, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ORALLY TEST STUDENTS' ABILITY TO RECOGNIZE DISTRIBUTOR PARTS BY HOLDING UP A COMPONENT AND CHOOSING A STUDENT TO NAME IT, DESCRIBE ITS FUNCTION, AND ANSWER PERTINENT QUESTIONS ABOUT IT.

EXAMPLE: HOLD UP A BREAKER POINT SET AND ASK THE QUESTIONS:

1. WHAT IS THIS COMPONENT CALLED?
ANSWER: BREAKER POINT SET OR THE POINTS
2. WHAT IS ITS FUNCTION?
ANSWER: BREAKS THE PRIMARY CIRCUIT AND ALLOWS FOR DWELL
3. IF THE SPRING IS TOO STRONG, WHAT MIGHT HAPPEN?
ANSWER: CAN CAUSE EXCESSIVE RUBBING BLOCK WEAR
4. WHAT WILL RUBBING BLOCK WEAR DO?
ANSWER: REDUCE POINT GAP CAUSING THEM TO ARC AND BURN AND THROW OFF DWELL AND TIMING

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE

1. A DISTRIBUTOR SHOULD ALWAYS BE TIMED AFTER IT IS INSTALLED. T
2. AFTER IT IS TIMED, THE POINT GAP SHOULD BE ADJUSTED. F
3. THE HOLD DOWN CLAMP IS USEFUL IN GETTING THE DISTRIBUTOR TO SEAT. F
4. THE DRIVE GEAR HAS AN EXACT LOCATION ON THE DISTRIBUTOR SHAFT. T
5. MOST CENTRIFUGAL ADVANCE UNITS HAVE AN INTERNAL DIAPHRAGM. F
6. DISTRIBUTOR LUBRICATION POINTS NEED ONLY A FEW DROPS OF OIL. T
7. HIGH TEMPERATURE GREASE IS USED ON THE CAM SURFACE. T
8. A VACUUM ADVANCE UNIT OPERATES DUE TO WEIGHTS AND SPRINGS.
9. A DWELL METER IS BEST FOR ADJUSTING USED POINTS. T
10. CONTACT SPRING AND RESISTANCE ROD ARE PARTS OF A ROTOR. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

DISTRIBUTOR COMPONENTS ARE LISTED ALONG WITH THEIR TYPICAL DAMAGE, CAUSES OF DAMAGE, AND CORRECTIVE MEASURES.

THERE ARE SEVERAL LUBRICATION POINTS ON A DISTRIBUTOR, AND EACH REQUIRES ONLY A FEW DROPS OF OIL.

AUTOMATIC SPARK ADVANCE UNITS SHOULD BE KEPT CLEAN, AND DEFECTIVE PARTS SHOULD BE REPLACED.

DISTRIBUTOR OVERHAUL SHOULD BE FOLLOWED WITH A BENCH TEST. THE DISTRIBUTOR SHOULD BE TIMED AFTER IT IS INSTALLED, BUT ONLY AFTER THE POINTS ARE ADJUSTED.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CH. 15

THE NEXT LESSON IS: VIII-C-18(I), "ELECTRONIC IGNITION" (CHRYSLER)

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

VIII-C-8(S)

| | |
|---|---|
| TASK: | DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR |
| AIM: | THE STUDENT WILL BE ABLE TO REMOVE, DISASSEMBLE, CHECK COMPONENTS FOR WEAR AND SERVICE, INSTALL NEW PARTS, AND ASSEMBLE DISTRIBUTOR: USING TOOLS, EQUIPMENT, PARTS, AND SPECIFICATIONS CALLED FOR IN THE JOB. |
| TOOLS AND EQUIPMENT: | HAND TOOLS, FENDER COVERS, SEAT COVER, DROP LIGHT, DRIFT PUNCH, "V" BLOCK, REAMER AND HANDLE, SCRIBE, MICROMETER, BUSHING KNOCKERS, DIAL INDICATOR |
| MATERIALS: | HIGH TEMPERATURE LUBRICANT, CLEAN RAGS, SOLVENT, CROCUS CLOTH |
| TEACHING AIDS: | JOB AND TASK SHEETS, CHALKBOARD |
| REFERENCES: | AUTOMECHANICS, PP. 285-288, 308-311<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 407-417<br>AUTO SERVICE AND REPAIR, PP. 21-8 TO 21-22<br>AUTOMOTIVE MECHANICS, PP. 365-366, 369 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS. THE STUDENT MUST BE ABLE TO IDENTIFY THE PARTS OF A DISTRIBUTOR. THE STUDENT MUST BE ABLE TO RECITE THE FUNCTIONS AND OPERATION OF THE PARTS OF A DISTRIBUTOR. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS, EQUIPMENT, SUPPLIES, AND PARTS<br>2. PREPARATION FOR PERFORMANCE OF JOB<br>3. HOLD ALL DIMENSIONS TO SPECIFICATIONS<br>4. MAINTAIN ALL TOOLS AND EQUIPMENT IN GOOD WORKING CONDITION<br>5. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE<br>6. SAFE WORKING HABITS<br>7. CRAFTSMANLIKE PERFORMANCE OF THE JOB |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

DISASSEMBLY OF AN AUTOMOBILE ENGINE IGNITION DISTRIBUTOR VARIES ACCORDING TO THE DISTRIBUTOR CONSTRUCTION. FOR INSTANCE, SOME DISTRIBUTORS HAVE THE CENTRIFUGAL ADVANCE MECHANISM LOCATED

## I. PREPARATION (CON'T.)

ABOVE THE CAM AND POINTS, WHILE OTHERS HAVE THE CENTRIFUGAL ADVANCE MOUNTED BELOW THE CAM AND BREAKER POINT PLATE.

IT BECOMES NECESSARY TO SERVICE AND REPAIR A DISTRIBUTOR WHEN WEAR BECOMES EXCESSIVE IN THE BUSHINGS, SHAFT, GEAR, AND CAM. TOO, ADVANCE MECHANISM WILL FAIL TO FUNCTION PROPERLY AND REQUIRE SERVICE.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION AND PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 2. REMOVE DISTRIBUTOR | 1. FROM ENGINE<br>2. REMOVE COIL TO DISTRIBUTOR SECONDARY LEAD<br>NOTE: HAVE PAN OR BASKET HANDY TO PLACE PARTS IN AS THEY ARE REMOVED<br>3. DISCONNECT IGNITION PRIMARY LEAD AT DISTRIBUTOR OR COIL<br>4. DIRECT LIGHT ON FLYWHEEL OR HARMONIC BALANCE, WHICHEVER HAS IGNITION TIMING MARK<br>5. BUMP ENGINE OVER WITH STARTER UNTIL TIMING MARK APPEARS<br>6. FINISH MOVING TIMING MARK INTO ALIGNMENT WITH INDICATOR BY PULLING ON FAN BELT TO TURN ENGINE OVER<br>NOTE: IT MAY BE NECESSARY TO REMOVE THE SPARK PLUGS IN ORDER TO RELIEVE THE COMPRESSION FOR EASE OF TURNING ENGINE OVER<br>NOTE: THIS OPERATION IS TO PLACE NUMBER ONE PISTON IN FIRING POSITION AND AID IN INSTALLING DISTRIBUTOR<br>7. TRACE NUMBER ONE SPARK PLUG WIRE TO DISTRIBUTOR CAP TERMINAL TOWER<br>NOTE: THIS IS TO AID IN POSITIONING |

ROTOR CAP FOR NUMBER ONE CYLINDER WHEN DISTRIBUTOR IS REINSTALLED

8. RAISE DISTRIBUTOR CAP
    a. DISENGAGE SPRING HOLD DOWN CLIPS OR
    b. PRESS DOWN ON "L" CLAMPS WITH SCREWDRIVER AND TURN TO FREE CAP
9. NOTE ROTOR CAP POSITION, ROTOR CAP METAL TIP SHOULD BE DIRECTLY OVER SCRIBED LINE ON DISTRIBUTOR HOUSING

NOTE: IF ROTOR CAP METAL TIP IS NOT DIRECTLY OVER SCRIBED LINE:

    a. DISTRIBUTOR DRIVE GEAR OR COUPLING IS BROKEN
    b. DRIVE PIN HAS SHEARED
    c. TIMING GEAR IS BROKEN OR HAS JUMPED
10. REMOVE VACUUM ADVANCE TUBE FROM VACUUM ADVANCE DIAPHRAGM ASSEMBLY
11. REMOVE DISTRIBUTOR CLAMP HOLD-DOWN BOLT
12. REMOVE SECONDARY WIRING FROM DISTRIBUTOR CAP
13. LIFT DISTRIBUTOR FROM ENGINE MOUNTING

3. DISASEMBLE DISTRIBUTOR

1. REMOVE ROTOR CAP
    a. LIFT OFF POST "OR"
    b. REMOVE TWO SCREWS AND LIFT OFF
2. REMOVE POINTS AND CONDENSER
3. REMOVE PRIMARY LEAD
4. REMOVE CONTACT SUPPORT LOCK SCREW
5. LIFT OUT CONTACT SUPPORT
6. REMOVE VACUUM CONTROL UNIT
    a. REMOVE HAIRPIN FROM VACUUM CONTROL ARM PIVOT
    b. REMOVE SCREWS FROM VACUUM TO DISTRIBUTOR HOUSING

    - c. LIFT OFF VACUUM CONTROL UNIT
- 7. REMOVE BREAKER PLATE
    - a. REMOVE TWO RETAINING SCREWS
    - b. REMOVE BEARING RETAINER CLIPS
    - c. LIFT OUT BREAKER PLATE
- 8. EXPOSE GOVERNOR WEIGHTS
    - a. REMOVE FELT WICK FROM CAM WELL
    - b. REMOVE CAM LOCK RING FROM GROOVE IN SHAFT
- 9. LIFT CAM OFF SHAFT
- 10. REMOVE GOVERNOR WEIGHTS AND SPRINGS

CAUTION: EXERCISE CARE NOT TO STRETCH GOVERNOR SPRINGS

4. REMOVE DISTRIBUTOR SHAFT

- 1. FROM HOUSING
- 2. LAY DISTRIBUTOR FLAT ON BENCH
- 3. SUPPORT GEAR AND SHAFT IN "V" BLOCK
- 4. TURN SHAFT UNTIL LOCKING PIN IS VERTICAL
- 5. REMOVE GEAR OR COLLAR FROM SHAFT
    - a. USE PIN PUNCH AND HAMMER
    - b. DRIVE PIN OUT OF SHAFT AND GEAR OR COLLAR
    - c. SLIDE COLLAR OR GEAR OFF SHAFT
- 6. LIFT SHAFT OUT OF HOUSING

NOTE: IN CASE SHAFT DOES NOT LIFT OUT OF THE HOUSING; USE SOFT FACED HAMMER AND DRIVE SHAFT OUT

5. CLEAN AND INSPECT PARTS

- 1. USE NON-INFLAMMABLE SOLVENT

NOTE: CONDENSER AND LEADS ARE NOT TO BE WASHED

- 2. PUT ON FACE SHIELD OR GOGGLES
- 3. CLEAN PARTS
    - a. USE SOLVENT
    - b. WIPE WITH CLEAN RAG
    - c. FINISH DRYING WITH COMPRESSED AIR

NOTE: IN CASE AN OIL CRUST HAS COOKED OR DRIED ON SHAFT, BUFF

CLEAN WITH BENCH GRINDER MOTOR AND WIRE WHEEL, WASH AND DRY

4. CHECK SHAFT WEAR AT BEARING SURFACE
   a. USE MICROMETER
   b. CHECK MANUFACTURER'S SPECIFICATIONS FOR SHAFT DIAMETER
   c. CLEARANCE BETWEEN BUSHING AND SHAFT IS NOT TO EXCEED .006 INCH
5. CHECK SHAFT FOR RUN-OUT
   a. PLACE SHAFT IN "V" BLOCKS
   b. USE DIAL INDICATOR
   c. MOUNT DIAL INDICATOR OVER SHAFT WITH SENSOR TOUCHING SHAFT
   d. ZERO DIAL INDICATOR
   e. ROTATE SHAFT

NOTE: IF RUN-OUT EXCEEDS .002 INCH SHAFT MUST BE REPLACED

6. INSPECT GOVERNOR WEIGHTS FOR:
   a. WEAR
   b. BURNS
   c. FREE FIT ON PINS
7. INSPECT GOVERNOR WEIGHT SPRINGS FOR:
   a. DISTORTION
   b. WEAK
   c. BROKEN
8. BREAKER PLATE MOUNTED ON STEEL BALLS, INSPECT FOR:
   a. WEAR IN HOUSING GROOVE
   b. ROUGH HOUSING GROOVE
   c. NICKS IN HOUSING GROOVE
   d. ROUGH OR NICKED BALLS

NOTE: IN SOME CASES A GROOVE RELINER WITH SMALLER BALLS IS AVAILABLE FOR REPAIRS

9. TWO PIECE BREAKER PLATE INSPECT BUSHING FOR:
   a. ROUGHNESS

| | |
|---|---|
| | b. STICKING<br>c. SIDE PLAY |
| 6. REMOVE HOUSING BUSHINGS | 1. MOUNT DISTRIBUTOR HOUSING IN VISE<br>2. USE PROTECTIVE JAWS IN VISE<br>3. USE BUSHING KNOCKER SLIGHTLY SMALLER THAN OUTSIDE DIAMETER OF BUSHING<br>4. DRIVE BUSHINGS OUT WITH KNOCKER AND HAMMER |
| 7. INSTALL NEW DISTRIBUTOR HOUSING BUSHINGS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR BEARING TYPE AND SIZE<br>2. SELECT BEARING<br>3. PRESS BEARING INTO HOUSING OR USE KNOCKER AND HAMMER<br>NOTE: TAKE CARE NOT TO DAMAGE BEARING AND HOUSING<br>4. CHECK MANUFACTURER'S SPECIFICATIONS FOR INSIDE DIAMETER OF THE BEARING<br>5. BURNISH BEARING I.D. TO SIZE |
| 8. INSPECT DISTRIBUTOR CAP | 1. MAKE SURE CAP IS CLEAN<br>2. INSPECT FOR:<br>a. CRACKS<br>b. CARBON TRACKS<br>c. BURNED OR CORRODED TERMINALS<br>d. CENTER TERMINAL<br>(1) DAMAGED<br>(2) WORN |
| 9. INSPECT CAM | 1. FOR WEAR<br>2. CHECK MANUFACTURER'S SPECIFICATIONS |
| 10. ASSEMBLE DISTRIBUTOR | 1. LUBRICATE BEARING SURFACES OF DISTRIBUTOR SHAFT WITH HIGH TEMPERATURE LUBRICANT<br>2. POSITION SHAFT IN DISTRIBUTOR HOUSING<br>3. LAY DISTRIBUTOR FLAT ON BENCH<br>4. SLIDE GEAR OR COLLAR ONTO SHAFT<br>5. ALIGN PIN HOLES IN GEAR OR COLLAR WITH PIN HOLE IN SHAFT |

6. SUPPORT GEAR OR COLLAR AND SHAFT IN "V" BLOCK
7. TURN SHAFT AND GEAR OR COLLAR UNTIL LOCKING PIN HOLES ARE VERTICAL
8. POSITION PIN IN HOLE
9. DRIVE PIN IN HOLE LOCKING GEAR OR COLLAR TO SHAFT
10. LIGHTLY LUBRICATE GOVERNOR (CENTRIFUGAL ADVANCE)
11. POSITION GOVERNOR IN HOUSING
12. SLIDE CAN ONTO SHAFT
13. INSTALL CAM LOCKING RING INTO GROOVE IN SHAFT
14. INSTALL FELT WICK INTO CAM WELL
15. POSITION BREAKER PLATE IN HOUSING
16. INSTALL BEARING RETAINER CLIPS
17. INSTALL AND TIGHTEN BREAKER RETAINING SCREWS
18. POSITION VACUUM CONTROL UNIT TO HOUSING
19. INSTALL VACUUM ADVANCE TO HOUSING MOUNTING SCREWS AND TIGHTEN
20. POSITION VACUUM CONTROL ARM OVER PIVOT
21. INSTALL HAIRPIN ON VACUUM CONTROL ARM PIVOT PIN
22. INSTALL POINTS

ROUTE DISTRIBUTOR TO DISTRIBUTOR TESTER

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS USE JOB AND TAKS SHEETS.
2. HAVE STUDENTS PRACTICE ON JOB.
3. SUPERVISE STUDENT PRACTICE.
4. RETEACH IF THE NEED ARISES.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON THEIR OWN.
2. USE PERFORMANCE TEST.

3. ENTER RESULTS ON PROGRESS CHART.

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V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE PROCEDURE FOR REMOVAL OF DISTRIBUTOR TO FACILITATE EASE OF REPLACEMENT.
   a. POSITIONING NUMBER ONE CYLINDER WITH TIMING MARK.
   b. SCRIBING DISTRIBUTOR HOUSING UNDER NUMBER ONE CAP TERMINAL TOWER.
2. EMPHASIZE CARE IN DISASSEMBLING DISTRIBUTOR AND PLACING PARTS IN PARTS CONTAINER.
3. EMPHASIZE CARE AND SAFETY IN THE CLEANING OF PARTS.
4. EMPHASIZE CRAFTSMANLIKE PERFORMANCE IN ASSEMBLY OF DISTRIBUTOR.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, PP. 290-295
AUTOMOTIVE ENCYCLOPEDIA, PP. 404-416
AUTO SERVICE AND REPAIR, PP. 21-7 TO 21-22
AUTOMOTIVE MECHANICS, PP. 365-366, 369

THE NEXT LESSON IS: VIII-C-9(S), "TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR"

# JOB SHEET
# IN
# IGNITION SYSTEM

| | |
|---|---|
| JOB: | DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR |
| MATERIALS: | DISTRIBUTOR SHAFT BUSHINGS, CLEAN RAGS, SOLVENT, HEAT RESISTANT LUBRICANT |
| TOOLS AND EQUIPMENT: | HAND TOOLS, SEAT COVER, FENDER COVERS, DROP LIGHT, MICROMETER, "V" CLOCK, PIN PUNCH HAMMER, BURNISHING TOOLS, REAMER WITH HANDLE |
| GENERAL INSTRUCTIONS: | BEFORE STARTING THIS JOB READ THE REFERENCES AND STUDY THE JOB AND TASK SHEETS. CHECK WITH THE INSTRUCTOR BEFORE STARTING EACH TASK AND UPON COMPLETION OF EACH TASK. |

| | | |
|---|---|---|
| PROCEDURES AND/OR TASKS: | VIII-C-8(TS) | REMOVE DISTRIBUTOR |
| | VIII-C-8a(TS) | DISASSEMBLE DISTRIBUTOR AND CLEAN PARTS |
| | VIII-C-8b(TS) | ASSEMBLE DISTRIBUTOR |

## TASK SHEET

VIII-C-8(TS)

TASK: REMOVE DISTRIBUTOR

JOB: DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, SCRIBE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION AND PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 2. ALIGN TIMING MARK | 1. POSITION NUMBER ONE CYLINDER IN FIRING POSITION<br>2. REMOVE IGNITION PRIMARY LEAD FROM COIL POST<br>3. REMOVE COIL TO DISTRIBUTOR SECONDARY WIRE FROM DISTRIBUTOR CAP TOWER<br>4. DIRECT LIGHT ON HARMONIC BALANCE AT FRONT OF ENGINE AND TIMING MARK<br>5. BUMP ENGINE OVER WITH STARTER UNTIL TIMING MARK ON HARMONIC BALANCE APPEARS<br>6. FINISH MOVING TIMING MARK ON HARMONIC BALANCE INTO ALIGNMENT WITH MARK ON BLOCK BY PULLING ON FAN BELT TO TURN ENGINE OVER<br>CAUTION: REMOVE NEGATIVE LEAD FROM BATTERY BEFORE PULLING ON FAN BELT<br>NOTE: IT MAY BE NECESSARY TO REMOVE SPARK PLUGS TO RELIEVE COMPRESSION SO THAT THE ENGINE CAN BE ROTATED BY PULLING ON BELT<br>NOTE: THIS OPERATION IS PERFORMED TO AID IN EASE OF INSTALLING DISTRIBUTOR |

| STEPS | KEY POINTS |
|---|---|
| 3. SCRIBE DISTRIBUTOR HOUSING | 1. TRACE NUMBER ONE SPARK PLUG WIRE FROM SPARK PLUG TO NUMBER ONE DISTRIBUTOR CAP TERMINAL TOWER<br>2. SCRIBE LINE ON DISTRIBUTOR HOUSING DIRECTLY UNDER CENTER OF NUMBER ONE DISTRIBUTOR TERMINAL TOWER<br>NOTE: THIS OPERATION IS TO AID IN POSITIONING ROTOR CAP FOR NUMBER ONE CYLINDER WHEN DISTRIBUTOR IS INSTALLED<br>3. UNFASTEN DISTRIBUTOR CAP HOLD DOWN SPRING CLIPS OR "L" CLAMPS<br>4. RAISE DISTRIBUTOR CAP<br>5. NOTE ROTOR CAP POSITION, METAL TIP OF ROTOR CAP SHOULD BE DIRECTLY OVER SCRIBED LINE ON THE HOUSING<br>NOTE: IF ROTOR CAP METAL TIP IS NOT DIRECTLY OVER SCRIBED LINE:<br>a. DISTRIBUTOR DRIVE GEAR OR COUPLING IS BROKEN<br>b. DRIVE PIN HAS SHEARED<br>c. TIMING GEAR IS BROKEN OR HAS JUMPED |
| 4. REMOVE DISTRIBUTOR | 1. FROM ENGINE<br>2. CHECK SPECIFICATIONS FOR FIRING ORDER<br>3. MARK DISTRIBUTOR CAP WITH FIRING ORDER<br>4. REMOVE SECONDARY WIRING FROM DISTRIBUTOR CAP<br>5. PLACE CAP IN PARTS BASKET<br>6. REMOVE VACUUM ADVANCE TUBE FROM VACUUM ADVANCE UNIT<br>7. REMOVE DESTRIBUTOR CLAMP HOLD-DOWN BOLT, USE THE DISTRIBUTOR WRENCH<br>8. PLACE HOLD-DOWN BOLT AND CLAMP IN PARTS BASKET<br>9. LIFT DISTRIBUTOR FROM ENGINE |

| STEPS | KEY POINTS |
|---|---|
| | MOUNT |
| | 10. PLACE DISTRIBUTOR ON BENCH |

TASK SHEET VIII-C-8a(TS)

TASK: DISASSEMBLE DISTRIBUTOR AND CLEAN PARTS

JOB: DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, "V" BLOCK, HAMMER, PIN PUNCH, SOLVENT, CLEAN RAGS, DIAL INDICATOR

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE ROTOR CAP | 1. GRASP ROTOR CAP WITH HAND AND LIFT OFF PART OR<br>2. REMOVE TWO HOLD-DOWN SCREWS AND LIFT CAP OFF |
| 2. REMOVE POINTS AND CONDENSER | REFER TO TASK VIII-C-6 |
| 3. REMOVE CONTACT SUPPORT | 1. REMOVE LOCKING SCREW<br>2. LIFT OUT CONTACT SUPPORT<br>3. PLACE PARTS IN PARTS BASKET |
| 4. REMOVE VACUUM CONTROL UNIT | 1. REMOVE HAIRPIN FROM VACUUM CONTROL ARM PIVOT<br>2. REMOVE SCREWS FROM VACUUM CONTROL TO DISTRIBUTOR HOUSING<br>3. LIFT OFF VACUUM CONTROL UNIT<br>4. PLACE PARTS IN PARTS BASKET |
| 5. REMOVE BREAKER PLATE | 1. REMOVE TWO RETAINING SCREWS<br>2. REMOVE BEARING RETAINER CLIPS<br>3. LIFT OUT BREAKER PLATE<br>4. PLACE PARTS IN PARTS BASKET |
| 6. REMOVE CAM AND GOVERNOR WEIGHTS | 1. REMOVE FELT WICK FROM CAM WELL, USE NEEDLE NOSE PLIERS<br>2. REMOVE CAM LOCKING RING FROM GROOVE IN SHAFT, USE LOCK-RING-PLIERS<br>3. LIFT CAM OFF SHAFT<br>4. LIFT OUT GOVERNOR WEIGHTS AND SPRINGS<br>CAUTION: EXERCISE CARE NOT TO STRETCH OR DAMAGE GOVERNOR SPRINGS |

| STEPS | KEY POINTS |
|---|---|
| | 5. PLACE PARTS IN PARTS BASKET |
| 7. REMOVE DISTRIBUTOR SHAFT | 1. LAY DISTRIBUTOR FLAT ON BENCH |
| | 2. TURN SHAFT UNTIL LOCKING PIN IN COLLAR OR GEAR IS VERTICAL |
| | 3. SUPPORT GEAR OR COLLAR AND SHAFT IN "V" BLOCK |
| | 4. DRIVE PIN OUT OF GEAR OR COLLAR AND SHAFT, USE PIN PUNCH AND HAMMER |
| | 5. SLIDE GEAR OR COLLAR FROM SHAFT |
| | 6. LIFT SHAFT OUT OF HOUSING |
| | NOTE: IF SHAFT DOES NOT LIFT OUT OF THE HOUSING; USE SOFT FACED HAMMER AND DRIVE SHAFT OUT |
| 8. CLEAN PARTS | 1. PUT ON GOGGLES |
| | 2. USE NON-INFLAMMABLE SOLVENT |
| | NOTE: CONDENSER AND LEADS ARE NOT TO BE WASHED |
| | 3. WIPE CONDENSER AND LEADS CLEAN WITH CLEAN DRY RAG |
| | 4. INSPECT LEADS FOR CONDITION OF GOOD REPAIR |
| | 5. WASH ALL PARTS |
| | 6. DRY WITH CLEAN DRY RAG |
| | 7. FINISH DRYING PARTS WITH COMPRESSED AIR |
| | NOTE: IN CASE AN OIL CRUST HAS COOKED OR DRIED ON DISTRIBUTOR SHAFT, BUFF SHAFT CLEAN WITH BENCH GRINDER AND WIRE WHEEL, WASH AND DRY |
| 9. CHECK SHAFT | 1. AT BEARING SURFACE |
| | 2. USE MICROMETER |
| | 3. REFER TO MANUFACTURER'S SPECIFITIONS FOR SHAFT DIAMETER |
| | NOTE: CLEARANCE BETWEEN BUSHING AND SHAFT IS NOT TO EXCEED .006 INCH |
| | 4. CHECK SHAFT FOR RUN-OUT |

| STEPS | KEY POINTS |
|---|---|
| | 5. PLACE SHAFT IN "V" BLOCKS<br>6. MOUNT DIAL INDICATOR ON PEDESTAL<br>7. POSITION DIAL INDICATOR OVER SHAFT<br>8. POSITION DIAL INDICATOR SENSOR TOUCHING SHAFT<br>9. ZERO DIAL INDICATOR<br>10. ROTATE SHAFT<br>11. NOTE READING ON DIAL INDICATOR<br>NOTE: IF RUN-OUT EXCEEDS .002 INCH SHAFT MUST BE REPLACED |
| 10. INSPECT GOVERNOR WEIGHTS | 1. WEAR<br>2. BURNS<br>3. FREE FIT ON PINS<br>4. SPRINGS FOR:<br>a. DISTORTION<br>b. WEAK<br>c. BROKEN |
| 11. INSPECT STEEL BALL MOUNTED TYPE BREAKER PLATE | 1. INSPECT GROOVE FOR WEAR<br>2. INSPECT GROOVE FOR ROUGHNESS<br>3. INSPECT GROOVE FOR NICKS<br>4. INSPECT STEEL BALLS FOR NICKS<br>NOTE: IN SOME CASES GROOVE RE-LINERS WITH SMALLER STEEL BALLS ARE AVAILABLE FOR REPAIRS |
| 12. INSPECT TWO PIECE TYPE BREAKER PLATE BUSHING | 1. FOR ROUGHNESS<br>2. FOR STICKING<br>3. FOR SIDE PLAY |
| 13. INSPECT DISTRIBUTOR CAP | 1. FOR CRACKS<br>2. FOR CARBON TRACKS<br>3. FOR BURNED OR CORRODED TERMINALS<br>4. CENTER ELECTRODE<br>a. FOR DAMAGE<br>b. FOR WEAR |
| 14. INSPECT CAM | 1. CHECK MANUFACTURER'S SPECIFICATIONS<br>2. FOR WEAR |

## TASK SHEET

TASK: ASSEMBLE DISTRIBUTOR

JOB: DISASSEMBLE AND ASSEMBLE IGNITION DISTRIBUTOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, REAMER, CLEAN RAGS, HEAT RESISTANT LUBRICANT, PIN PUNCH HAMMER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE DISTRIBUTOR HOUSING BUSHINGS | 1. MOUNT DISTRIBUTOR HOUSING IN VISE VERTICALLY |
| | 2. USE PROTECTIVE JAWS IN VISE |
| | 3. USE BUSHING KNOCKER SLIGHTLY SMALLER THAN OUTSIDE DIAMETER OF BUSHING |
| | 4. PLACE KNOCKER IN BUSHING |
| | 5. PLACE HANDLE IN KNOCKER |
| | 6. DRIVE BUSHINGS OUT WITH HAMMER |
| 2. INSTALL NEW BUSHINGS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR BEARING SIZE |
| | 2. SELECT BUSHINGS |
| | 3. POSITION BUSHINGS IN HOUSING |
| | NOTE: BUSHINGS MAY BE PRESSED INTO HOUSING OR DRIVEN IN WITH KNOCKER AND HAMMER |
| | 4. USE SAME KNOCKER AS USED FOR REMOVING BUSHINGS FOR PRESSING OR HAMMERING BUSHINGS INTO PLACE |
| | NOTE: EXERCISE CARE NOT TO DAMAGE BUSHING |
| 3. SIZE BUSHINGS | 1. SELECT PROPER SIZE REAMER AS SPECIFIED BY MANUFACTURER WITH HANDLE |
| | 2. A CUT OF .002 INCH IS RECOMMENDED WITH THE HAND REAMER |
| | 3. ALIGN REAMER VERTICALLY WITH HOLE IN BUSHING |
| | 4. START REAMER BY TURNING CLOCKWISE |

| STEPS | KEY POINTS |
|---|---|
| | 5. USE A SLOW, STEADY, SCREWLIKE MOTION TO REAM HOLE |
| | NOTE: REAMER IS NOT TO BE FORCED OR STRAINED AND IS ALWAYS TURNED CLOCKWISE |
| | 6. TURN REAMER CLOCKWISE AND PULL FROM HOLE |
| | 7. BURNISH HOLE SMOOTH IN BUSHING WITH CROCUS CLOTH |
| | 8. CLEAN HOUSING AND BUSHING THOROUGHLY |
| 4. INSTALL SHAFT IN DISTRIBUTOR HOUSING | 1. LUBRICATE BEARING SURFACES OF DISTRIBUTOR SHAFT WITH HIGH TEMPERATURE LUBRICANT |
| | 2. POSITION SHAFT IN DISTRIBUTOR HOUSING |
| | 3. LAY DISTRIBUTOR FLAT ON BENCH |
| | 4. POSITION GEAR OR COLLAR ON SHAFT |
| | 5. ALIGN KEEPER PIN HOLES IN GEAR OR COLLAR WITH HOLE IN SHAFT |
| | 6. ROTATE SHAFT UNTIL KEEPER HOLES ARE VERTICAL |
| | 7. SUPPORT GEAR OR COLLAR AND SHAFT IN "V" BLOCK |
| | 8. POSITION KEEPER PIN IN HOLE IN GEAR OR COLLAR |
| | 9. DRIVE PIN INTO HOLE LOCKING GEAR OR COLLAR TO SHAFT |
| 5. INSTALL GOVERNOR | 1. FASTEN DISTRIBUTOR IN VISE WITH GEAR END OF DISTRIBUTOR DOWN |
| | 2. LIGHTLY LUBRICATE GOVERNOR (CENTRIFUGAL ADVANCE) |
| | 3. POSITION GOVERNOR IN HOUSING |
| 6. INSTALL CAM | 1. SLIDE CAM ONTO SHAFT |
| | 2. POSITION CAM AND SLIDE DOWN OVER GOVERNOR |
| | 3. INSTALL CAM LOCKING RING INTO GROOVE IN SHAFT |
| | 4. INSTALL FELT WICK INTO CAM WELL |

| STEPS | KEY POINTS |
|---|---|
| 7. INSTALL BREAKER PLATE | 1. POSITION BREAKER PLATE RIGHT SIDE UP IN HOUSING<br>2. INSTALL BEARING RETAINER CLIPS<br>3. INSTALL BREAKER PLATE RETAINING SCREWS AND TIGHTEN |
| 8. INSTALL VACUUM CONTROL UNIT | 1. POSITION VACUUM CONTROL UNIT TO HOUSING<br>2. INSTALL VACUUM ADVANCE TO HOUSING MOUNTING SCREWS AND TIGHTEN<br>3. POSITION VACUUM CONTROL ARM OVER PIVOT<br>4. INSTALL HAIRPIN ON VACUUM CONTROL ARM PIVOT PIN |
| 9. INSTALL POINTS | SEE TASK VIII-C-6b(TS) |
| 10. CLEAN WORK STATION | AS IN PRECEDING TASKS |

ROUTE DISTRIBUTOR TO THE DISTRIBUTOR TESTER

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

**TASK:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**AIM:**

1. THE STUDENT WILL BE ABLE TO UTILIZE DISTRIBUTOR TEST EQUIPMENT AND DETERMINE THE NEED FOR REPLACEMENT OF PARTS OR ADJUSTMENT OF DISTRIBUTOR COMPONENTS.
2. THE STUDENT WILL BE ABLE TO MAKE NECESSARY DISTRIBUTOR COMPONENT ADJUSTMENTS TO PLACE A DISTRIBUTOR IN EFFICIENT WORKING ORDER.
3. THE STUDENT WILL BE ABLE TO CORRECTLY INSTALL AND HOOK UP AN IGNITION DISTRIBUTOR CAUSING IT TO FUNCTION EFFECTIVELY AND EFFICIENTLY IN FURNISHING PRIMARY AND SECONDARY IGNITION CURRENT AND VOLTAGE TO AN ENGINE.

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** JOB AND TASK SHEETS

**REFERENCES:**
AUTOMECHANICS, PP. 290-295
AUTOMOTIVE ENCYCLOPEDIA, PP. 404-416
AUTO SERVICE AND REPAIR, PP. 21-17 TO 21-22
AUTOMOTIVE MECHANICS, PP. 365-366, 369

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST BE ABLE TO IDENTIFY THE PARTS OF A DISTRIBUTOR AND RECITE THE FUNCTIONS OF EACH. TOO, THE STUDENT MUST BE ABLE TO IDENTIFY DISTRIBUTOR PROBLEMS.

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. SETUP OF TEST EQUIPMENT
3. EFFECTIVE USE OF TEST EQUIPMENT
4. EFFECTIVE RESULTS FROM USE OF TEST EQUIPMENT
5. CRAFTSMANLIKE PERFORMANCE OF TASKS
6. AN ATTITUDE OF APPRECIATION FOR TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE
7. SAFE WORKING HABITS

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THIS LESSON WILL DEAL WITH GENERAL PRINCIPLES TO BE FOLLOWED FOR TESTING AN IGNITION DISTRIBUTOR WITH A TESTER. METHODS OF TESTING DISTRIBUTORS MAY VARY WITH TESTERS OF DIFFERENT MANUFACTURE.

## I. PREPARATION (CON'T.)

FOR INSTRUCTIONS USED WITH A SPECIFIC TESTER REFER TO THE MANUFACTURER'S SPECIFICATIONS AND MANUAL.

DISTRIBUTOR ADJUSTMENTS ARE VERY CRITICAL AND HAVE MUCH TO DO WITH THE EFFECTIVE OPERATION OF AN AUTOMOBILE ENGINE. MISADJUSTMENTS AND POOR WORKMANSHIP SHOW UP AS A HARD STARTING ENGINE, POOR ACCELERATION, JERKING ENGINE, AND POOR GAS MILEAGE.

ON OCCASIONS AN ENGINE WILL NOT RUN CORRECTLY EVEN AFTER A TUNE-UP. IN THIS CASE THE TROUBLE MUST BE TRACED DOWN. IN ORDER TO TRACE DOWN AND ISOLATE TROUBLES A MECHANIC MUST HAVE A COMPLETE UNDERSTANDING OF THE FUNCTIONS AND OPERATION OF EACH OF THE THREE SYSTEMS THAT CAUSE AN ENGINE TO FUNCTION EFFICIENTLY OR INEFFICIENTLY. THESE SYSTEMS CAN BE CLASSIFIED AS CARBURETION, IGNITION, AND COMPRESSION.

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. MOUNT DISTRIBUTOR ON TESTER | 1. OPEN SUPPORT ARM JAWS BY BACKING OUT ON LOCKING SCREW |
| | 2. INSERT DISTRIBUTOR LOWER HOUSING INTO SUPPORT JAWS |
| | 3. INSERT DISTRIBUTOR SHAFT LOWER END INTO TESTER DRIVE CHUCK |
| | 4. ROTATE DISTRIBUTOR SHAFT TO CHECK FOR FREE ROTATION |
| | 5. SECURELY TIGHTEN TESTER DRIVE CHUCK TO DISTRIBUTOR SHAFT |
| | 6. ROTATE CHUCK BY HAND TO MAKE SURE SHAFT TURNS FREELY |
| | 7. TIGHTEN SUPPORT JAWS SECURELY ON DISTRIBUTOR LOWER HOUSING WITH LOCKING SCREW |
| | 8. MAKE NECESSARY ELECTRICAL CONNECTION FOR TESTER |
| | 9. CONNECT SYNCHROGRAPH TEST LEAD TO PRIMARY TERMINAL OR PRIMARY LEAD WIRE OF DISTRIBUTOR |
| 2. TEST BREAKER POINT RESISTANCE | 1. TURN TEST SELECTOR TO RESISTANCE CHECK POSITION |
| | 2. ROTATE CHUCK BY HAND |
| | 3. CLOSE BREAKER POINT CONTACTS |

4. OBSERVE CAM ANGLE METER NEEDLE, METER NEEDLE SHOULD BE POINTING TO OK OR GOOD ZONE OF THE METER SCALE

NOTE: IF THE METER DOES NOT INDICATE GOOD OR OK

a. THERE IS EXCESSIVE RESISTANCE ACROSS THE POINTS
   (1) THIS CAN BE IMPROPER SPRING TENSION, SEE TASK VIII-C-6c(TS)
   (2) BURNED OR PITTED POINTS, SEE TASK VIII-C-6b(TS)
b. DAMAGED PRIMARY LEAD, SECURE NEW LEAD AND INSTALL
c. POORLY GROUNDED BASE PLATE, REMOVE BASE PLATE, CLEAN, AND REINSTALL

3. TEST INSULATION AND LEAKAGE

1. TURN TEST SELECTOR TO CAM ANGLE POSITION
2. ROTATE CHUCK BY HAND
3. OPEN BREAKER POINT CONTACTS
4. OBSERVE CAM ANGLE METER NEEDLE, NEEDLE SHOULD INDICATE ZERO

NOTE: IF THE NEEDLE DOES NOT INDICATE ZERO

a. SHORT CIRCUIT TO GROUND EXISTS
b. POOR PRIMARY WIRE INSULATION, REPLACE PRIMARY WIRE
c. SHORTED CONDENSER, REPLACE CONDENSER, SEE TASK VIII-C-6b(TS)
d. SHORT BETWEEN BREAKER ARM AND BREAKER PLATE, REMOVE AND INSULATE, SEE TASK VIII-C-6(TS)

4. TEST DISTRIBUTOR MECHANICAL OPERATION

1. MANUALLY CHECK ADVANCE MECHANISM
2. TURN DISTRIBUTOR SHAFT BY HAND SLIGHTLY IN DIRECTION OF ROTATION
3. RELEASE SHAFT

NOTE: SHAFT WILL RETURN TO ORIGINAL POSITION IF:

- a. DISTRIBUTOR PARTS HAVE FREEDOM OF ROTATION
- b. MECHANICAL ADVANCE SPRINGS ARE ADJUSTED PROPERLY AND IN GOOD CONDITION

4. MAKE CONNECTIONS FOR SPARKING PROTRACTOR

NOTE: REFER TO TESTER MANUFACTURER'S HANDBOOK FOR HOOKUP

5. TURN ON CHUCK DRIVE MOTOR
6. ADJUST SPEED CONTROL TODRIVE DISTRIBUTOR AT 400 TO 4000 RPM OR FROM 400 RPM TO MAXIMUM RPM OF ENGINE ON WHICH DISTRIBUTOR IS USED

NOTE: ERRATIC OR THIN FAINT FLASHES PRECEDING THE REGULAR FLASHES ON THE PROTRACTOR AS RPM IS INCREASED CAN BE:

- a. WEAK BREAKER ARM SPRING TENSION
- b. BINDING OF BREAKER ARM ON PIVOT PIN
- c. REPAIR PROBLEM, REFER TO TASKS VIII-C-6b(TS) AND VIII-C-6c(TS)

7. OPERATE TESTER AT 2500 RPM
8. ZERO PROTRACTOR SCALE OPPOSITE ANY ONE OF THE NEON FLASHES, MOVE PROTRACTOR BY HAND

NOTE: REMAINING CYLINDER FLASHES SHOULD APPEAR TO BE EVENLY SPACED AROUND THE PROTRACTOR PLUS OR MINUS ONE DEGREE

NOTE: VARIATIONS LARGER THAN ONE DEGREE, ERRATIC, OR WANDERING FLASHES CAN BE:

- a. WORN CAM
- b. WORN DISTRIBUTOR SHAFT

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c. WORN DISTRIBUTOR HOUSING BUSHINGS
d. BENT DISTRIBUTOR SHAFT

5. TEST ANGLE OF DWELL

SEE TASK SHEET VIII-C-7(TS), USE SAME PROCEDURE WITH DISTRIBUTOR ON TESTER

6. TEST FOR BREAKER PLATE WEAR

NOTE: WORN BREAKER PLATE WILL USUALLY CAUSE BREAKER POINT GAP AND CONTACT POINT DWELL TO BE ERRATIC AS ENGINE SPEED AND LOAD CONDITIONS ARE VARIED

1. ADJUST TEST SET TO ZERO DEGREE ADVANCE
2. SET VACUUM AT ZERO
3. SET SPEED AT 100 RPM
4. SET DWELL ANGLE TO 26 DEGREES
5. CONNECT VACUUM TUBE TO VACUUM ADVANCE UNIT
6. APPLY VACUUM TO VACUUM ADVANCE UNIT VERY SLOWLY
7. OBSERVE INDICATED ANGLE OF DWELL ON METER

NOTE: MAXIMUM ANGLE OF DWELL VARIATION SHOULD NOT EXCEED FOUR DEGREES WHEN APPLYING VACUUM FROM ZERO TO MAXIMUM AT A CONSTANT SPEED. IF THE ANGLE OF DWELL VARIATION EXCEEDS FOUR DEGREES THERE IS EXCESSIVE BREAKER PLATE WEAR

8. REPAIR OR REPLACE BREAKER PLATE

7. TEST VACUUM ADVANCE DIAPHRAGM

1. ADJUST TESTER VACUUM PRESSURE TO 25 INCHES OF HG OR SLIGHTLY LESS
2. HOLD HAND OVER END OF TESTER VACUUM HOSE AND NOTE VACUUM READING ON DIAL, 25 INCHES HG IS NOT TO BE EXCEEDED
3. CONNECT TESTER VACUUM LINE TO FITTING ON DIAPHRAGM UNIT
4. OBSERVE READING ON VACUUM GAUGE

NOTE: VACUUM READING SHOULD NOT BE LESS THAN IT WAS BEFORE INSTALLING THE TUBE ON THE DIAPHRAGM UNIT. IF THE READING IS LESS THE DIAPHRAGM IS LEAKING AND MUST BE REPLACED

8. TEST VACUUM ADVANCE UNIT

1. CONNECT TESTER VACUUM LINE TO ADVANCE UNIT FITTING
2. SET TEST SET AT ZERO DEGREE ADVANCE
3. SET VACUUM AT ZERO
4. SET TESTER SPEED AT 1000 RPM
5. CHECK MANUFACTURER'S SPECIFICATIONS FOR VACUUM SETTINGS
6. CHECK ADVANCE AT FIRST VACUUM SETTING AS GIVEN IN SPECIFICATIONS
7. IF ADVANCE IS INCORRECT, WITH DIAPHRAGM IN GOOD CONDITION
   a. USE 1/8 INCH ALLEN WRENCH
   b. INSERT ALLEN WRENCH IN SOCKET HEAD SCREW IN VACUUM UNIT
   c. TURN ALLEN WRENCH CLOCKWISE TO INCREASE VACUUM ADVANCE
   d. TURN ALLEN WRENCH COUNTERCLOCKWISE TO DECREASE VACUUM ADVANCE
   e. REMOVE ALLEN WRENCH
8. RPM TO REMAIN THE SAME FOR ALL CHECKS
9. CONTINUE TEST AT DIFFERENT VACUUM SPECIFICATIONS

NOTE: SOME DIAPHRAGM VACUUM UNITS CANNOT BE ADJUSTED, UNIT MUST BE REPLACED. CHECK MANUFACTURER'S SPECIFICATIONS

9. INSTALL DISTRIBUTOR

1. ALIGN TIMING MARKS ON ENGINE TO PUT NUMBER ONE PISTON IN FIRING POSITION
2. ALIGN ROTOR WITH SCRIBED MARK ON DISTRIBUTOR HOUSING
3. ROTATE DISTRIBUTOR SO THAT THE SCRIBED MARK WILL BE POINTING IN APPROXIMATELY SAME DIRECTION AS

WHEN DISTRIBUTOR WAS REMOVED

A. GEAR DRIVEN DISTRIBUTOR

1. TURN ROTOR SLIGHTLY IN REVERSE OF ROTATION
2. INSERT DISTRIBUTOR INTO ENGINE BLOCK PORT
3. SHOVE THE DISTRIBUTOR DOWN INTO PLACE
4. AS THE DISTRIBUTOR MOVES DOWN ROTOR WILL TURN SLIGHT AMOUNT AS THE DISTRIBUTOR GEAR MESHES, THE ROTOR SHOULD BE ALIGNED WITH THE SCRIBED MARK ON THE HOUSING
5. IF THE ROTOR DOES NOT MATCH THE SCRIBED LINE
   a. PULL DISTRIBUTOR UP ENOUGH TO CLEAR THE GEARS
   b. MOVE THE ROTOR BACK OR FORWARD ENOUGH TO COMPENSATE FOR THE ROTOR TURNING
   c. PRESS DISTRIBUTOR DOWN AGAIN
6. PRESS THE DISTRIBUTOR HOUSING FLANGE DOWN FLUSH WITH THE BLOCK
7. IF THE DISTRIBUTOR HOUSING FLANGE DOES NOT FLUSH UP WITH THE BLOCK,
   a. DO NOT FORCE THE DISTRIBUTOR DOWN BY USING THE HOLD-DOWN
   b. PRESS DOWN ON THE DISTRIBUTOR BY HAND AND CRANK THE ENGINE OVER
   c. THE DISTRIBUTOR SHOULD FALL INTO PLACE
8. INSTALL HOLD-DOWN FLANGE AND BOLT
9. SNUG HOLD-DOWN BOLT DOWN BUT ALLOW DISTRIBUTOR TO TURN FOR TIMING

B. SLOT AND TANG DRIVEN DISTRIBUTOR

1. ALIGN ROTOR WITH SCRIBED MARK ON DISTRIBUTOR HOUSING
2. PSOITION SCRIBED MARK IN THE SAME DIRECTION AS WHEN THE DISTRIBUTOR WAS REMOVED
3. PLACE DISTRIBUTOR IN BLOCK
4. SHOVE DOWN ON DISTRIBUTOR

| | |
|---|---|
| | 5. IF SLOT AND TANG DO NOT MATCH, ROCK THE ROTOR BACK AND FORTH SLIGHTLY |
| | 6. FLUSH UP DISTRIBUTOR HOUSING FLANGE AND BLOCK |
| | 7. INSTALL HOLD-DOWN CLAMP AND BOLT |
| 10. INSTALL WIRING AND HOSES | 1. INSTALL DISTRIBUTOR CAP<br>2. INSTALL SECONDARY WIRING<br>3. CONNECT PRIMARY LEAD<br>4. CONNECT VACUUM ADVANCE VACUUM LINE |
| 11. TIME DISTRIBUTOR | REFER TO VIII-C-7 |
| 12. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. USE JOB AND TASK SHEETS.
2. HAVE STUDENTS PRACTICE UNDER CLOSE SUPERVISION.
3. CHECK EACH STUDENT FOR CORRECT PROCEDURE AND RESULTS.
4. RETEACH IF THE NEED ARISES.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PUT STUDENTS ON THEIR OWN.
2. USE PERFORMANCE TEST.
3. IF RESULTS ARE NOT SATISFACTORY HAVE STUDENTS PERFORM JOB OVER AND RETEST.
4. RECORD RESULTS ON PROGRESS CHART.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY.
2. EMPHASIZE CRAFTSMANSHIP.
3. EMPHASIZE THE NEED FOR ACCURACY.
4. POINT OUT NEED FOR STEP BY STEP PROCEDURE FOR CHECKING EACH

INDIVIDUAL UNIT OF DISTRIBUTOR.

5. POINT OUT CORRECTIVE MEASURES TAKEN WITH EACH UNIT OF DISTRIBUTOR.

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SUGGESTED READING FOR STUDENTS:

INFORMATION SHEET VIII-C-3(IS)
"ISOLATING IGNITION PROBLEMS ON THE VEHICLE"

THE NEXT LESSON IS: VIII-C-10(S), "TEST AND SERVICE ELECTRONIC IGNITION SYSTEM"

VIII-C-9(J)

# JOB SHEET
# IN
# IGNITION SYSTEM

**JOB:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, DISTRIBUTOR TESTER

**GENERAL INSTRUCTIONS:** READ REFERENCES AND STUDY JOB AND TASK SHEETS BEFORE BEGINNING THIS JOB. CONFER WITH INSTRUCTOR AT SPECIFIED POINTS BEFORE CONTINUING WITH TASKS AND BEFORE USING TEST EQUIPMENT. IN DEALING WITH ELECTRICITY ALWAYS PRACTICE SAFETY MEASURES.

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-C-9(TS) | MOUNT DISTRIBUTOR ON TESTER |
| VIII-C-9a(TS) | TEST BREAKER POINT RESISTANCE |
| VIII-C-9b(TS) | TEST INSULATION AND LEAKAGE |
| VIII-C-9c(TS) | TEST DISTRIBUTOR MECHANICAL OPERATION |
| VIII-C-7(TS) | ADJUST DISTRIBUTOR BREAKER POINTS ANGLE OF DWELL |
| VIII-C-9d(TS) | TEST BREAKER PLATE WEAR |
| VIII-C-9e(TS) | TEST VACUUM ADVANCE DIAPHRAGM |
| VIII-C-9f(TS) | TEST VACUUM ADVANCE UNIT |
| VIII-C-9g(TS) | INSTALL DISTRIBUTOR |
| VIII-C-9h(TS) | ADJUST IGNITION TIMING |

## TASK SHEET VIII-C-9(TS)

| | |
|---|---|
| TASK: | MOUNT DISTRIBUTOR ON TESTER |
| JOB: | TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | DISTRIBUTOR TESTER, HAND TOOLS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE TESTER | 1. TURN ALL TESTER SWITCHES TO OFF POSITION |
| | 2. MAKE NECESSARY ELECTRICAL CONNECTIONS FOR TESTER, WALL OUTLETS, AND/OR BATTERY AS SPECIFIED BY MANUFACTURER |
| | 3. OPEN DISTRIBUTOR SUPPORT ARM JAWS BY BACKING OUT ON LOCKING SCREW |
| | 4. OPEN DISTRIBUTOR DRIVE CHUCK JAWS TO RECEIVE DISTRIBUTOR SHAFT END |
| 2. POSITION DISTRIBUTOR ON TESTER | 1. PICK UP DISTRIBUTOR BY HOUSING |
| | 2. ROTATE DISTRIBUTOR SHAFT AND CHECK FOR FREE ROTATION |
| | 3. INSERT DISTRIBUTOR LOWER ROUND HOUSING INTO OPENING OF SUPPORT ARM JAWS |
| | 4. INSERT LOWER END OF DISTRIBUTOR DRIVE SHAFT INTO TESTER DRIVE CHUCK |
| | 5. IT MAY BE NECESSARY TO ADJUST THE DISTRIBUTOR SUPPORT UP OR DOWN TO PROPERLY SEAT HOUSING IN SUPPORT AND SHAFT IN CHUCK |
| 3. ADJUST DRIVE CHUCK | 1. MAKE SURE DISTRIBUTOR DRIVE SHAFT IS FAR ENOUGH DOWN INTO CHUCK FOR FIRM CONNECTION |
| | 2. CENTER SHAFT IN CHUCK |
| | 3. SECURELY TIGHTEN DRIVE CHUCK TO DISTRIBUTOR SHAFT |
| | 4. ROTATE CHUCK BY HAND TO MAKE SURE SHAFT TURNS FREELY |

| STEPS | KEY POINTS |
|---|---|
| 4. SECURE DISTRIBUTOR HOUSING | 1. MAKE FINAL ADJUSTMENT OF DISTRIBUTOR SUPPORT UP OR DOWN FOR PROPER HOUSING MOUNT<br>2. TIGHTEN SUPPORT JAWS FIRMLY TO HOUSING |

## TASK SHEET

VIII-C-9a(TS)

TASK: TEST BREAKER POINT RESISTANCE

JOB: TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, DISTRIBUTOR TESTER, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE TESTER | 1. CONNECT SYNCHROGRAPH TEST LEAD TO PRIMARY LEADWIRE TERMINAL OR TO TERMINAL ON DISTRIBUTOR<br>2. TURN TEST SELECTOR SWITCH TO RESISTANCE CHECK POSITION |
| 2. PERFORM TEST | 1. ROTATE CHUCK BY HAND TURNING DISTRIBUTOR SHAFT<br>2. CLOSE BREAKER POINTS CONTACT<br>3. OBSERVE CAM ANGLE METER<br>4. METER NEEDLE SHOULD BE POINTING TO OK OR GOOD ZONE OF THE METER SCALE |
| 3. IMPROPER READING AND NECESSARY SERVICE | NOTE: IF THE METER DOES NOT INDICATE GOOD OR OK:<br>1. THERE IS EXCESSIVE RESISTANCE ACROSS THE POINTS<br>a. THIS CAN BE IMPROPER BREAKER POINT SPRING TENSION, FOR SERVICE SEE TASK VIII-C-6c(TS)<br>b. BURNED OR PITTED POINTS, FOR SERVICE SEE TASK VIII-C-6b(TS)<br>2. DAMAGED PRIMARY LEAD, SECURE NEW LEAD AND INSTALL<br>3. POORLY GROUNDED BASE PLATE, REMOVE BASE PLATE, CLEAN, AND REINSTALL |

TASK SHEET VIII-C-9b(TS)

**TASK:** TEST INSULATION AND LEAKAGE

**JOB:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, DISTRIBUTOR TESTER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE TESTER | 1. CONNECT SYNCHROGRAPH TEST LEAD TO PRIMARY LEAD WIRE TERMINAL OR TO PRIMARY TERMINAL ON DISTRIBUTOR<br>2. TURN TEST SELECTOR SWITCH TO CAM ANGLE POSITION |
| 2. PERFORM TEST | 1. ROTATE TESTER CHUCK BY HAND<br>2. OPEN BREAKER POINT CONTACTS<br>3. OBSERVE CAM ANGLE METER<br>4. METER NEEDLE SHOULD INDICATE ZERO |
| 3. IMPROPER READING AND NECESSARY SERVICE | NOTE: IF THE NEEDLE DOES NOT INDICATE ZERO<br>1. SHORT CIRCUIT TO GROUND EXISTS, SEARCH OUT SHORT AND REPAIR<br>2. POOR PRIMARY WIRE INSULATION, REPLACE PRIMARY WIRE<br>3. SHORTED CONDENSER, REPLACE CONDENSER OR REMOVE SHORTED CONDITION, SEE TASK VIII-C-6b(TS)<br>4. SHORT BETWEEN BREAKER ARM AND BREAKER PLATE, REMOVE POINTS AND INSULATE OR REPLACE POINTS, SEE TASK VIII-C-6b(TS) |

# TASK SHEET VIII-C-9c(TS)

**TASK:** TEST DISTRIBUTOR MECHANICAL OPERATION

**JOB:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, DISTRIBUTOR TESTER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. MANUALLY CHECK ADVANCE MECHANISM | 1. TURN DISTRIBUTOR SHAFT BY HAND<br>2. TURN SHAFT SLIGHTLY IN DIRECTION OF ROTATION<br>3. RELEASE SHAFT<br>NOTE: SHAFT WILL RETURN TO ORIGINAL POSITION IF:<br>a. DISTRIBUTOR PARTS HAVE FREEDOM OF ROTATION<br>b. MECHANICAL ADVANCE SPRINGS ARE ADJUSTED PROPERLY AND IN GOOD CONDITION |
| 2. CHECK BREAKER ARM OPERATION | 1. MAKE CONNECTIONS TESTER TO DISTRIBUTOR FOR SPARKING THE PROTRACTOR<br>2. REFER TO DISTRIBUTOR TESTER MANUFACTURER'S HANDBOOK FOR HOOKUP<br>3. TURN ON CHUCK DRIVE MOTOR<br>4. ADJUST SPEED CONTROL TO DRIVE DISTRIBUTOR AT 400 RPM<br>5. OBSERVE NEON FLASHES ON THE PROTRACTOR<br>6. GRADUALLY INCREASE SPEED TO 4000 RPM OR TO MAXIMUM RPM OF ENGINE ON WHICH DISTRIBUTOR IS USED<br>7. OBSERVE NEON FLASHES ON PROTRACTOR AS RPM IS INCREASED<br>NOTE: ERRATIC OR THIN FAINT FLASHES PRECEDING REGULAR FLASHES ON THE PROTRACTOR AS RPM IS INCREASED CAN BE: |

| STEPS | KEY POINTS |
|---|---|
| | a. WEAK BREAKER ARM SPRING TENSION |
| | b. BINDING OF BREAKER ARM ON PIVOT PIN |
| | c. REPAIR AS IN TASKS VIII-C-6b(TS) AND VIII-C-6c(TS) |
| 3. CHECK DISTRIBUTOR SHAFT, BUSHINGS, AND CAM | 1. SET DISTRIBUTOR CHUCK DRIVE SPEED AT 2500 RPM |
| | 2. MOVE PROTRACTOR BY HAND |
| | 3. ZERO PROTRACTOR SCALE OPPOSITE ANYONE OF THE NEON FLASHES |
| | 4. REMAINING CYLINDER FLASHES SHOULD APPEAR EVENLY SPACED AROUND THE PROTRACTOR PLUS OR MINUS ONE DEGREE |
| | NOTE: VARIATIONS LARGER THAN ONE DEGREE, ERRATIC, OR WANDERING FLASHES CAN BE: |
| | a. WORN CAM |
| | b. WORN DISTRIBUTOR SHAFT |
| | c. WORN DISTRIBUTOR HOUSING BUSHINGS |
| | d. BENT DISTRIBUTOR SHAFT |
| | e. FOR REPAIRS SEE JOB VIII-C-8(J) |

## TASK SHEET

VIII-C-9d(TS)

**TASK:** TEST BREAKER PLATE WEAR

**JOB:** TEST, ADJUST, AND INSTALL INGITION DISTRIBUTOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, DISTRIBUTOR TESTER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| | NOTE: WORN BREAKER PLATE WILL USUALLY CAUSE BREAKER POINT GAP AND CONTACT POINT DWELL TO BE ERRATIC AS ENGINE SPEED AND LOAD CONDITIONS ARE VARIED |
| 1. PREPARE MACHINE FOR TEST | 1. ADJUST TEST SET TO ZERO DEGREES ADVANCE<br>2. SET VACUUM AT ZERO<br>3. SET DWELL ANGLE METER ON 26 DEGREES<br>4. SET CHUCK SPEED AT 100 RPM<br>5. CONNECT VACUUM TUBE TO VACUUM ADVANCE UNIT |
| 2. PERFORM TEST | 1. APPLY VACUUM TO VACUUM ADVANCE UNITE VERY SLOWLY<br>2. OBSERVE INDICATED ANGLE OF DWELL ON METER<br>3. MAXIMUM ANGLE OF DWELL VARIATION SHOULD NOT EXCEED FOUR DEGREES WHEN APPLYING VACUUM FROM ZERO TO MAXIMUM AT A CONSTANT SPEED<br>4. IF THE ANGLE OF DEGREES VARIATION EXCEEDS FOUR DEGREES THERE IS EXCESSIVE BREAKER PLATE WEAR<br>5. REPAIR OR REPLACE BREAKER PLATE |

## TASK SHEET

VIII-C-9e(TS)

TASK: TEST VACUUM ADVANCE DIAPHRAGM

JOB: TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, DISTRIBUTOR TESTER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE MACHINE FOR TEST | 1. REMOVE VACUUM TUBE FROM VACUUM ADVANCE UNIT<br>2. ADJUST TESTER VACUUM PRESSURE TO 25 INCHES OF HG OR SLIGHTLY LESS<br>3. HOLD HAND OVER END OF VACUUM TUBE TO SEAL IT<br>4. NOTE VACUUM READING INDICATED ON DIAL<br>5. 25 INCHES HG IS NOT TO BE EXCEEDED<br>6. REMOVE HAND FROM END OF TUBE |
| 2. PERFORM TEST | 1. CONNECT TESTER VACUUM LINE TO FITTING ON DIAPHRAGM UNIT<br>2. OBSERVE READING ON VACUUM GAUGE<br>3. VACUUM READING SHOULD NOT BE LESS THAN IT WAS BEFORE INSTALLING THE TUBE ON THE DIAPHRAGM<br>4. IF THE READING IS LESS, THE DIAPHRAGM IS LEAKING AND MUST BE REPLACED |

# TASK SHEET

VIII-C-9f(TS)

| | |
|---|---|
| TASK: | TEST VACUUM ADVANCE UNIT |
| JOB: | TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, DISTRIBUTOR TESTER |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FOR TEST | 1. CONNECT TESTER VACUUM LINE TO VACUUM ADVANCE UNIT FITTING |
| | 2. SET TEST SET AT ZERO DEGREE ADVANCE |
| | 3. SET VACUUM ON ZERO |
| | 4. SET TESTER CHUCK SPEED AT 1000 RPM |
| | 5. CHECK MANUFACTURER'S SPECIFICATIONS FOR VACUUM TEST SETTING |
| 2. PERFORM TEST | 1. CHECK ADVANCE AT FIRST SETTING AS GIVEN IN SPECIFICATIONS |
| | 2. IF ADVANCE IS INCORRECT AND DIAPHRAGM IS IN GOOD CONDITION<br>a. USE 1/8 INCH ALLEN WRENCH IN SOCKET HEAD SCREW IN VACUUM UNIT<br>b. TURN ALLEN WRENCH CLOCKWISE TO INCREASE VACUUM ADVANCE<br>c. TURN ALLEN WRENCH COUNTERCLOCKWISE TO DECREASE VACUUM ADVANCE<br>d. REMOVE ALLEN WRENCH |
| | 3. RPM TO REMAIN THE SAME FOR ALL TESTS |
| | 4. CONTINUE TESTS AT DIFFERENT VACUUM SPECIFICATIONS<br><br>NOTE: SOME DIAPHRAGM VACUUM UNITS CANNOT BE ADJUSTED, UNIT MUST BE REPLACED. CHECK MANUFACTURER'S SPECIFICATION |
| | 5. REMOVE DISTRIBUTOR FROM TESTER<br>a. LOOSEN CHUCK<br>b. LOOSEN SUPPORT JAWS |

| STEPS | KEY POINTS |
|---|---|
| | c. DISCONNECT ELECTRICAL CONNECTIONS |
| | 6. TURN OFF TESTER |
| | 7. DISCONNECT ELECTRICAL POWER |
| | 8. CLEAN TESTER AND STORE |

**TASK SHEET** VIII-C-9g(TS)

**TASK:** INSTALL DISTRIBUTOR

**JOB:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, SEAT COVER, FENDER COVERS, DROP LIGHT, TIMING LIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE AND DISTRIBUTOR | 1. ALIGN TIMING MARK ON ENGINE TO PUT NUMBER ONE PISTON IN FIRING POSITION |
| | 2. ALIGN ROTOR WITH SCRIBE MARK ON DISTRIBUTOR HOUSING |
| | 3. ROTATE DISTRIBUTOR SO THAT SCRIBE MARK WILL BE POINTING IN APPROXIMATELY SAME DIRECTION AS WHEN DISTRIBUTOR WAS REMOVED |
| A. GEAR DRIVE DISTRIBUTOR | 1. TURN DISTRIBUTOR ROTOR SLIGHTLY IN REVERSE OF ROTATION |
| | 2. INSERT DISTRIBUTOR INTO ENGINE BLOCK PORT |
| | 3. SHOVE THE DISTRIBUTOR DOWN INTO PLACE |
| | 4. WHEN THE DISTRIBUTOR IS SHOVED DOWN THE ROTOR WILL TURN A SLIGHT AMOUNT AS THE GEARS MESH |
| | 5. THE ROTOR SHOULD NOW BE ALIGNED WITH THE SCRIBE MARK ON THE HOUSING |
| | 6. IF THE ROTOR DOES NOT MATCH THE SCRIBE LINE<br>a. PULL DISTRIBUTOR UP ENOUGH TO CLEAR THE GEARS<br>b. MOVE THE ROTOR BACK OR FORWARD ENOUGH TO COMPENSATE FOR THE ROTOR TURNING AS THE GEARS MESH<br>c. PRESS DISTRIBUTOR DOWN AGAIN |
| | 7. PRESS THE DISTRIBUTOR HOUSING FLANGE DOWN FLUSH WITH BLOCK |

| STEPS | KEY POINTS |
|---|---|
| | 8. IF THE DISTRIBUTOR HOUSING FLANGE DOES NOT FLUSH UP WITH THE BLOCK: |
| | a. DO NOT FORCE THE DISTRIBUTOR DOWN BY USING THE HOLD-DOWN CLAMP AND BOLT TO PULL IT DOWN |
| | b. PRESS DOWN ON THE DISTRIBUTOR AND HOLD IT FIRMLY IN POSITION BY HAND |
| | c. CRANK THE ENGINE OVER |
| | d. THE DISTRIBUTOR SHOULD FALL INTO PLACE |
| | 9. INSTALL HOLD - DOWN FLANGE AND BOLT |
| | 10. SNUG HOLD - DOWN BOLT DOWN BUT ALLOW DISTRIBUTOR TO TURN FOR TIMING |
| B. SLOT AND TANG DRIVE DISTRIBUTOR | 1. ALIGN ROTOR WITH SCRIBE MARK IN DISTRIBUTOR HOUSING |
| | 2. POSITION SCRIBE MARK IN SAME DIRECTION AS WHEN DISTRIBUTOR WAS REMOVED |
| | 3. PLACE DISTRIBUTOR IN BLOCK OPENING |
| | 4. SHOVE DOWN ON DISTRIBUTOR |
| | 5. IF SLOT AND TANG DO NOT MATCH ROCK ROTOR BACK AND FORTH SLIGHTLY |
| | 6. FLUSH UP DISTRIBUTOR HOUSING FLANGE AND BLOCK |
| | 7. INSTALL HOLD - DOWN CLAMP AND BOLT, SNUG UP BOLT |
| 2. INSTALL WIRING AND HOSES | 1. INSTALL DISTRIBUTOR CAP |
| | 2. INSTALL SECONDARY WIRING, SEE TASK SHEET |
| | 3. CONNECT PRIMARY LEAD |
| | 4. CONNECT VACUUM ADVANCE VACUUM HOSE |
| 3. TIME DISTRIBUTOR | REFER TO TASK SHEET |
| 4. CLEAN WORK STATION | |

## TASK SHEET

VIII-C-9h(TS)

**TASK:** ADJUST IGNITION TIMING

**JOB:** TEST, ADJUST, AND INSTALL IGNITION DISTRIBUTOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** SEAT COVER, FENDER COVER, TIMING LIGHT, TACH-DWELL METER, DISTRIBUTOR WRENCH, CLEAN RAGS, DROPLIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TIMING LIGHT | 1. CONNECT LOW-TENSION WIRES ACROSS BATTERY |
| | 2. CONNECT ONE HIGH-TENSION LEAD TO NUMBER ONE SPARK PLUG TERMINAL, MAKE SURE THERE IS A GOOD CONTACT |
| | 3. CONNECT SECOND HIGH-TENSION LEAD TO A GOOD GROUND |
| 2. PREPARE ENGINE FOR TIMING | 1. TURN CRANKSHAFT BY BUMPING STARTER |
| | 2. OBSERVE FLYWHEEL OR HARMONIC BALANCE ON FRONT OF CRANKSHAFT |
| | 3. STOP BUMPING ENGINE OVER WHEN TIMING MARK APPEARS |
| | 4. WIPE GREASE AND DIRT FROM TIMING MARK WITH CLEAN RAG |
| | 5. MARK TIMING MARK WITH NARROW BAND OF CHALK |
| | 6. REMOVE DISTRIBUTOR VACUUM ADVANCE HOSE FROM CARBURETOR OR INTAKE MANIFOLD<br>NOTE: THIS WILL PREVENT THE DISTRIBUTOR VACUUM ADVANCE FROM OPERATING AND AFFECTING TIMING ADJUSTMENT |
| | 7. TAPE UP VACUUM HOLE IN CARBURETOR OR MANIFOLD<br>NOTE: THIS IS TO PREVENT THE ENGINE FROM PULLING AIR INTO THE MANIFOLD CAUSING THE ENGINE TO RUN ROUGH |

| STEPS | KEY POINTS |
|---|---|
| | 8. MOVE TACH-DWELL METER INDICATOR SWITCH TO TACHOMETER POSITION |
| | 9. START ENGINE |
| | 10. SET ENGINE IDLE AT 500 RPM OR LESS |
| | NOTE: THIS IS TO PREVENT DISTRIBUTOR MECHANICAL ADVANCE FROM OPERATING |
| | 11. STOP ENGINE |
| | 12. LOOSEN DISTRIBUTOR HOLD DOWN BOLT |
| 3. SET IGNITION TIMING | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT TIMING SETTING |
| | 2. START ENGINE |
| | 3. DIRECT LIGHT FROM TIMING LIGHT ON HARMONIC BALANCE |
| | 4. OBSERVE TIMING MARK |
| | 5. TURN DISTRIBUTOR MOVING TIMING MARK TO RECOMMENDED SPECIFICATIONS |
| | 6. STOP ENGINE |
| | 7. TIGHTEN DISTRIBUTOR HOLD DOWN BOLT |
| | 8. START ENGINE RECHECK TIMING |
| | 9. RESET ENGINE RPM TO RECOMMENDED SPECIFICATIONS |
| | 10. STOP ENGINE |
| | 11. REMOVE TACH-DWELL METER |
| | 12. REMOVE TIMING LIGHT |
| | 13. REMOVE TAPE FROM VACUUM PORT |
| | 14. INSTALL DISTRIBUTOR VACUUM ADVANCE LINE ON VACUUM PORT |
| 4. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

CHRYSLER VIII-C-18(I)

**SUBJECT:** ELECTRONIC IGNITION

**AIM:**

1. THE STUDENT WILL BE ABLE TO RECITE THE NAMES OF THE ELECTRONIC IGNITION SYSTEM PARTS.
2. THE STUDENT WILL BE ABLE TO DISCUSS AND EXPLAIN THE FUNCTIONAL OPERATION OF THE ELECTRONIC IGNITION SYSTEM COMPONENTS.
3. THE STUDENT WILL BE ABLE TO DESCRIBE THE TESTING PROCEDURE FOR THE ELECTRONIC IGNITION SYSTEM.

**TEACHING AIDS:** DISPLAY OF ELECTRONIC IGNITION PARTS

**MATERIALS:**

**REFERENCES:**
INFORMATION SHEET, CHRYSLER VIII-C-14(IS)
"ELECTRONIC IGNITION"
AUTOMECHANICS, PP. 289-393
AUTOMOTIVE ENCYCLOPEDIA, PP. 433-435

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST HAVE SATISFACTORILY COMPLETED ALL ASSIGNMENTS AND TASKS FOR THE BREAKER POINT IGNITION SYSTEM. THE STUDENT MUST HAVE READ AND STUDIED THE REFERENCES FOR THIS LESSON.

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THIS IGNITION SYSTEM IS MUCH MORE EFFICIENT, ECONOMICAL, AND TROUBLE FREE THAN THE CONVENTIONAL BREAKER POINT IGNITION SYSTEM.

EVEN THOUGH THIS NEW IGNITION SYSTEM HAS BEEN LABELED WITH THE HIGH SOUNDING NAME, ELECTRONIC IGNITION SYSTEM, IT IS NO MORE COMPLICATED TO TEST, SERVICE, OR REPAIR THAN THE BREAKER POINT SYSTEM.

NO NEW FANCY TOOLS ARE NEEDED AND AN OSCILLOSCOPE, VOLTMETER, OHMMETER, AND TACHOMETER WILL TEST THE SYSTEM.

THE PRIMARY AIM IS TO FOLLOW MANUFACTURER'S INSTRUCTION, MAKE THE CORRECT TEST EQUIPMENT HOOK-UPS, MAKE SURE OF METER READINGS, AND CORRECT THE PROBLEM.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PARTS REMOVED | 1. BREAKER POINTS |

2. CONDENSER

B. PARTS RETAINED SAME AS BREAKER POINT SYSTEM

1. DISTRIBUTOR
   - a. HOUSING
   - b. CAP
   - c. ROTOR
   - d. VACUUM ADVANCE SYSTEM
2. COIL
3. HIGH TENSION LEADS
4. SPARK PLUGS

C. NEW PARTS ADDED

1. DISTRIBUTOR
   - a. RELUCTOR
   - b. MAGNETIC PICK-UP UNIT
2. DUAL BALLAST RESISTOR
3. CONTROL UNIT

D. RELUCTOR

1. REPLACES CAM AND RUBBING BLOCK
2. MOUNTED ON DISTRIBUTOR SHAFT
3. GEAR LIKE IN APPEARANCE WITH ONE LOBE FOR EACH ENGINE CYLINDER
4. NON-MAGNETIC, PROVIDES MAGNETIC PATH
5. REDUCES RELUCTANCE

E. PICK-UP UNIT

1. REPLACES BREAKER POINTS
2. MADE UP OF:
   - a. PERMANENT MAGNET
   - b. POLE PIECE
   - c. COIL WOUND AROUND POLE PIECE
3. RESEMBLES HORSESHOE TYPE MAGNET
4. RELUCTOR END OF POLE PIECE ACTS AS ONE POLE
5. NOT A SET OF POINTS
6. THERE IS NO CONTACT BETWEEN RELUCTOR AND PICK-UP UNIT

F. PICK-UP UNIT AND RELUCTOR ACTION

1. PERMANENT MAGNET PROVIDES MAGNETIC FIELD FROM POLE PIECE BACK TO ITSELF
2. MAGNETIC FIELD PASSES THROUGH COIL WOUND AROUND POLE PIECE
3. MAGNETIC FIELD IS RELATIVELY WEAK WHEN POLE PIECE IS BETWEEN LOBES ON RELUCTOR BECAUSE OF WIDE AIR GAP
4. AS RELUCTOR LOBE APPROACHES POLE PIECE PICK-UP MAGNETIC FIELD IS

INCREASED

5. INCREASING FIELD STRENGTH AT THE PICK-UP COIL INDUCES A POSITIVE VOLTAGE AT ONE TERMINAL OF THE COIL
6. POSITIVE VOLTAGE CONTINUES TO BUILD UP UNTIL A RELUCTOR LOBE IS EXACTLY OPPOSITE THE POLE PIECE

   NOTE: GAP BETWEEN POLE PIECE AND RELUCTOR IS .008"
7. AS SOON AS RELUCTOR LOBE PASSES POLE PIECE
   a. AIR GAP INCREASES
   b. FIELD STRENGTH BEGINS TO DECREASE
   c. NEGATIVE VOLTAGE IS INDUCED AT THE SAME TERMINAL OF THE COIL WINDING

   NOTE: VOLTAGE IS INDUCED BY THE CHANGE IN FIELD STRENGTH. NO VOLTAGE IS INDUCED IN THE PICK-UP COIL UNLESS THE RELUCTOR IS MOVING. A PICK-UP VOLTAGE IS VERY SMALL, A TINY ELECTRICAL SIGNAL THAT IS FED INTO THE ELECTRONIC CONTROL UNIT.

   IT IS A PRECISELY TIMED SIGNAL WHICH TRIGGERS THE ELECTRONIC CONTROL UNIT THUS CONTROLLING THE INTERRUPTION OF CURRENT FLOW THROUGH THE PRIMARY WINDINGS OF THE IGNITION COIL

G. DUAL BALLAST RESISTOR

1. 1/2 OHM RESISTOR ONE SIDE, SAME AS IN BREAKER POINT SYSTEM
2. SECOND RESISTOR IS 5 OHMS

1. 1/2 OHM RESISTOR

1. MAINTAINS CONSTANT CURRENT WITH VARIATIONS IN ENGINE RPM
2. PROTECTS IGNITION COIL AGAINST HIGH CURRENT FLOW AT LOW ENGINE RPM
3. BY PASSED WHEN CRANKING ENGINE, FULL BATTERY VOLTAGE IS APPLIED TO COIL

2. 5 OHM RESISTOR

1. PROTECTS CONTROL UNIT
2. LIMITS CURRENT FLOW IN ELECTRONIC PART OF CURRENT

H. CONTROL UNIT

1. SEALED
2. HAS NO MOVING PARTS
3. DETERMINES ELECTRICALLY HOW LONG IGNITION FLOWS BEFORE IT IS INTERRUPTED
4. DETERMINES ANGLE OF DWELL IN ELECTRONIC SYSTEM
   NOTE: DWELL CANNOT BE CHANGED
5. RELUCTOR AND PICK-UP UNIT DETERMINE IGNITION TIMING
6. CONTROL UNIT DETERMINES DWELL
   NOTE: RELUCTOR, PICK-UP UNIT, AND CONTROL UNIT ALL MUST WORK TOGETHER TO TIME THE INTERRUPTION OF THE IGNITION COIL PRIMARY CURRENT AND THE FIRING OF THE SPARK PLUGS

I. FIRING THE SPARK PLUGS

1. THE IGNITION SWITCH IS TURNED ON
2. THE ENGINE IS CRANKED OVER
3. BATTERY CURRENT FLOWS THROUGH IGNITION COIL PRIMARY WINDINGS
4. FROM COIL CURRENT FLOWS THROUGH GROUNDED CONTROL UNIT
   NOTE: CONTROL UNIT STAYS ACTIVE AND CURRENT IS FLOWING THROUGH THE IGNITION COIL PRIMARY WINDINGS SO LONG AS NEGATIVE VOLTAGE FROM THE PICK-UP UNIT IS NOT APPLIED TO THE CONTROL UNIT
5. RELUCTOR LOBE PASSES POLE PIECE AND NEGATIVE VOLTAGE TURNS OFF THE CONTROL UNIT
   NOTE: CURRENT CAN NO LONGER FLOW THROUGH THE CONTROL UNIT TO GROUND. THIS INTERRUPTS CURRENT THROUGH THE IGNITION COIL PRIMARY WINDINGS
6. THE INTERRUPTION OF CURRENT FLOW IN THE PRIMARY WINDING INDUCES VOLTAGE IN THE SECONDARY WINDINGS OF THE COIL
7. SECONDARY VOLTAGE IS THEN TRANSFERRED TO DISTRIBUTOR TO SPARK PLUGS AND FIRES THEM

J. ELECTRONIC IGNITION SYSTEM TEST EQUIPMENT

1. CHRYSLER IGNITION TESTER
2. VOLTMETER
3. OHMMETER
4. TACHOMETER
5. .008" NON-METALLIC FELLER GAUGE
6. JUMPER LEADS

1. INSPECT DISTRIBUTOR CAP AND ROTOR
    1. FIRST THING TO CHECK WHEN IGNITION PROBLEMS EXIST
    2. CHECK FOR CRACKS IN CAP OR ROTOR
    3. CHECK FOR TERMINAL CORROSION
    4. CHECK FOR CARBON TRACKING
2. SPARK PLUG INSPECTION
    1. REMOVE SPARK PLUGS
    2. CHECK SPECIFICATIONS
    3. INSPECT SPARK PLUGS FOR BREAKAGE AND BURNED ELECTRODES
    4. REGAP PLUGS
3. TEST HIGH TENSION LEADS
    1. INSPECT LEADS
        - a. BAD INSULATION
        - b. BROKEN STRANDS
        - c. TERMINAL CONDITION
    2. CHECK THEIR PERFORMANCE WITH AN OHMMETER OR OSCILLOSCOPE
4. TROUBLE SHOOTING BALLAST RESISTOR
    1. USE OHMMETER
    2. AUXILIARY RESISTOR SHOULD SHOW 4.75 TO 5.75 OHMS RESISTANCE
    3. WIRE WOUND RESISTOR SHOULD SHOW .5 TO .6 OHMS RESISTANCE

       NOTE: IF THE RESISTORS VARY FROM THESE SPECIFICATIONS OR SHOW AN OPEN CIRCUIT THE RESISTOR UNIT MUST BE REPLACED
5. TROUBLE SHOOTING PICK-UP COIL
    1. USE AN OHMMETER
    2. DISCONNECT CONNECTOR IN THE DUAL PRIMARY LEAD
    3. CHECK PICK-UP COIL RESISTANCE
    4. RESISTANCE SHOULD BE 400 TO 600 OHMS
    5. CHECK PICK-UP COIL INSULATION
        - a. CONNECT OHMMETER BETWEEN ONE CONNECTOR TERMINAL AND A GOOD GROUND
        - b. METER READING SHOULD BE INFINITY

NOTE: IF THE PICK-UP COIL RESISTANCE IS ABOVE OR BELOW SPECIFICATIONS, GROUNDED, OR HAS AN OPEN CIRCUIT: THE COIL MUST BE REPLACED

**6. PICK-UP COIL AIR GAP ADJUSTMENT**

NOTE: AIR GAP BETWEEN PICK-UP COIL AND RELUCTOR LOBES WILL CHANGE BECAUSE OF DISTRIBUTOR SHAFT AND BUSHING WEAR. ALSO, THE VACUUM ADVANCE PLATE WILL WEAR CAUSING AIR GAP CHANGE

PICK-UP COIL AIR GAP ADJUSTMENT IS VERY SIMILAR TO BREAKER POINT ADJUSTMENT

1. CRANK ENGINE OVER AND LINE UP ONE LOBE RELUCTOR WITH PICK-UP COIL POLE PIECE
2. LOOSEN PICK-UP COIL MOUNTING BRACKET LOCK SCREW
3. USE NON-MAGNETIC .008" FEELER GAUGE

   NOTE: IF NON-MAGNETIC FEELER GAUGE IS NOT AVAILABLE USE BRASS SHIM STOCK
4. PLACE FEELER GAUGE BETWEEN RELUCTOR LOBE AND POLE PIECE
5. MOVE COIL BRACKET UNTIL .008" GAP IS ARRIVED AT
6. TIGHTEN LOCKING SCREW
7. ROTATE ENGINE TWO COMPLETE REVOLUTIONS
8. CHECK AIR GAP AS EACH LOBE OF THE RELUCTOR MEETS POLE PIECE

   NOTE: IF ONE OR MORE RELUCTOR LOBES TOUCH THE POLE PIECE OR LOBES ARE DAMAGED CHECK THE DISTRIBUTOR SHAFT FOR SIDE PLAY. SIDE PLAY OF .006" OR MORE IS AN INDICATION THAT THE SHAFT, BUSHING, OR VACUUM ADVANCE IS WORN. DISTRIBUTOR MUST BE REMOVED AND REPAIRED OR REPLACED

**7. IGNITION COIL TEST**

1. USE COIL TESTER
2. REPLACE IF NECESSARY

| | |
|---|---|
| 8. ELECTRONIC CONTROL UNIT TEST | 1. TEST UNIT WITH CHRYSLER TEST UNIT<br>2. IF TESTER IS NOT AVAILABLE<br>a. TEST OTHER UNITS AS DESCRIBED IN PRECEDING TOPICS<br>b. IF PROBLEM PERSISTS REPLACE UNIT AS IT CANNOT BE REPAIRED |

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT PART HAS REPLACED THE BREAKER POINTS IN A CHRYSLER ELECTRONIC DISTRIBUTOR?

   PICK-UP UNIT

2. WHAT PART HAS REPLACED THE CAM AND RUBBING BLOCK IN A CHRYSLER ELECTRONIC DISTRIBUTOR?

   RELUCTOR

3. WHAT IS THE PURPOSE OF THE PERMANENT MAGNET IN THE PICK-UP UNIT?

   THE PERMANENT MAGNET PROVIDES A MAGNETIC FIELD FROM THE POLE PIECE BACK TO ITSELF.

4. HOW DOES THE RELUCTOR AFFECT THE MAGNETIC FIELD IN THE PICK-UP UNIT?

   AS A LOBE OF THE RELUCTOR APPROACHES THE POLE PIECE IT PROVIDES A BETTER PATH THAN THE AIR GAP AND THE MAGNETIC FIELD IN THE PICK-UP IS INCREASED.

5. WHAT EFFECT DOES THE INCREASED MAGNETIC FIELD HAVE ON THE PICK-UP COIL?

   INCREASED MAGNETIC FIELD INCREASES THE FIELD STRENGTH AT THE PICK-UP COIL INDUCING A POSITIVE VOLTAGE AT ONE TERMINAL OF THE COIL.

6. WHAT IS THE FUNCTION OF THE SIGNAL VOLTAGE INDUCED IN THE PICK-UP UNIT?

   IT TRIGGERS THE ELECTRONIC CIRCUITRY IN THE CONTROL UNIT TURNING IT ON AND OFF.

7. WHAT EFFECT DOES THE CONTROL UNIT HAVE ON THE IGNITION SYSTEM WHEN IT IS TURNED ON BY THE SIGNAL VOLTAGE FROM THE PICK-UP UNIT?

IT INTERRUPTS THE CURRENT FLOWING THROUGH THE PRIMARY WINDINGS OF THE IGNITION COIL.

8. WHY INTERRUPT THE COIL PRIMARY WINDINGS CURRENT FLOW?

IT INDUCES VOLTAGE IN THE COIL SECONDARY WINDINGS TO FIRE THE SPARK PLUGS.

9. WHAT IS THE PURPOSE OF THE DUAL BALLAST RESISTOR IN THE IGNITION SYSTEM?

EACH OF THE TWO RESISTORS HAS A PARTICULAR FUNCTION IN THE ELECTRONIC IGNITION SYSTEM.

a. THE 1/2 OHM RESISTOR PROTECTS THE IGNITION COIL AGAINST HIGH CURRENT FLOW AT LOW ENGINE RPM.
b. THE 5 OHM RESISTOR PROTECTS THE CONTROL UNIT BY LIMITING CURRENT FLOW IN THE ELECTRONIC PARTS OF THE CIRCUIT.

10. WHAT DETERMINES IGNITION TIMING IN THE CHRYSLER ELECTRONIC IGNITION SYSTEM?

THE DISTRIBUTOR RELUCTOR AND PICK-UP UNIT DETERMINES IGNITION TIMING IN THE CHRYSLER ELECTRONIC IGNITION.

11. WHEN INSPECTING AND TESTING HIGH TENSION LEADS WHAT DOES ONE LOOK FOR?

a. BAD INSULATION
b. BROKEN STRANDS
c. TERMINAL CONDITION
d. RESISTANCE IN LEADS

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

| | | |
|---|---|---|
| 1. | THE DISTRIBUTOR HOUSING, DISTRIBUTOR CAP, ROTOR, AND _____ MECHANISM ARE THE SAME FOR THE CHRYSLER ELECTRONIC IGNITION SYSTEM. | ADVANCE |
| 2. | THE PICK-UP UNIT IN THE DISTRIBUTOR CONSISTS OF A PERMANENT MAGNET AND A COIL WOUND AROUND A _____. | POLE PIECE |
| 3. | THE RELUCTOR WHICH IS ATTACHED TO THE DISTRIBUTOR SHAFT IN THE SAME POSITION AS THE CAM IN A BREAKER POINT SYSTEM IS A _____ LIKE COMPONENT. | GEAR |
| 4. | THE CLEARANCE BETWEEN A RELUCTOR LOBE AND THE PICK-UP UNIT POLE PIECE IS _____. | .008" |

## IV. VERIFICATION (CON'T.)

| | | |
|---|---|---|
| 5. | THE FEELER GAUGE USED TO SET THE RELUCTOR PICK-UP UNIT AIR GAP IS EITHER _____ OR BRASS SHIM STOCK. | NON-MAGNETIC |
| 6. | IN THE ELECTRONIC IGNITION SYSTEM, BATTERY CURRENT FLOWS THROUGH THE PRIMARY WINDINGS OF THE IGNITION COIL AND THEN THROUGH THE _____ WHICH IS GROUNDED. | CONTROL UNIT |
| 7. | WHEN A RELUCTOR LOBE PASSES THE POLE PIECE, AND THE PICK-UP VOLTAGE TURNS _____, IT DEACTIVATES THE CONTROL UNIT CIRCUITRY. | NEGATIVE |
| 8. | THE BALLAST RESISTORS ARE TESTED WITH AN _____ METER. | OHM |
| 9. | IF THE COMPONENTS OF AN ELECTRONIC IGNITION SYSTEM TEST OUT GOOD BUT THE IGNITION PROBLEM STILL EXISTS CHANGE OUT THE _____ UNIT. | CONTROL |
| 10. | AN ENGINE IS ROTATED THROUGH TWO COMPLETE REVOLUTIONS OF THE CRANKSHAFT TO CHECK FOR WEAR OF THE DISTRIBUTOR _____ AND BUSHING. | SHAFT |

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## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

I. DISTRIBUTOR PARTS RETAINED FOR ELECTRONIC IGNITION SYSTEM
   A. DISTRIBUTOR HOUSING AND CAP
   B. ROTOR CAP
   C. VACUUM ADVANCE SYSTEM

II. COIL, HIGH TENSION LEADS, AND SPARK PLUGS HAVE NOT BEEN CHANGED

III. NEW PARTS IN THE DISTRIBUTOR
   A. RELUCTOR-GEAR LIKE IN APPEARANCE WITH ONE LOBE FOR EACH CYLINDER OF THE ENGINE. REPLACES CAM AND RUBBING BLOCK.
   B. PICK-UP UNIT-HORSESHOE IN SHAPE. MADE UP OF PERMANENT MAGNET, POLE SHOE, AND COIL WOUND AROUND POLE SHOE. REPLACES BREAKER POINTS

IV. RELUCTOR AND PICK-UP UNIT CONTROL IGNITION TIMING

V. PERMANENT MAGNET OF PICK-UP UNIT PROVIDES MAGNETIC FIELD FROM POLE PIECE BACK TO ITSELF. MAGNETIC FIELD PASSES THROUGH COIL WOUND AROUND POLE PIECE. MAGNETIC FIELD BUILDS UP WITH HIGHEST POINT AT TIME RELUCTOR TOOTH IS EXACTLY OP-

POSITE POLE PIECE. ONE TERMINAL OF PICK-UP UNIT COIL IS POSITIVE AT THIS TIME. AFTER RELUCTOR TOOTH PASSES PICK-UP UNIT COIL BECOMES NEGATIVE AT SAME TERMINAL AS THE ONE THAT WAS POSITIVE. THIS ACTION TURNS CONTROL UNIT OFF AND ON

VI. DUAL BALLAST RESISTOR
  A. 1/2 OHM RESISTOR
    1. MAINTAINS CONSTANT PRIMARY CURRENT
    2. PROTECTS IGNITION COIL AGAINST HIGH CURRENT FLOW AT LOW ENGINE RPM
    3. BY PASSED WHEN ENGINE IS CRANKED
  B. 5 OHM RESISTOR
    1. PROTECTS CONTROL UNIT
    2. LIMITS CURRENT FLOW IN ELECTRONIC PART OF CIRCUIT

VII. CONTROL UNIT
  A. SEALED AND HAS NO MOVING PARTS
  B. DETERMINES ELECTRICALLY HOW LONG IGNITION COIL PRIMARY CURRENT FLOWS BEFORE IT IS INTERRUPTED
  C. DETERMINES ANGLE OF DWELL IN SYSTEM, DWELL CANNOT BE CONTROLLED

VIII. FIRST THINGS TO CHECK WHEN A PROBLEM EXISTS IN AN ELECTRONIC SYSTEM IS THE DISTRIBUTOR CAP AND ROTOR. CHECK FOR TERMINAL CORROSION, CARBON TRACKING, AND CRACKS

IX. TROUBLE SHOOTING BALLAST RESISTOR
  A. USE OHMMETER
  B. AUXILIARY RESISTOR, 5 OHM RESISTOR, SHOULD SHOW FROM 4.75 TO 5.75 OHMS RESISTANCE
  C. WIRE WOUND RESISTOR, 1/2 OHM RESISTOR, SHOULD SHOW FROM .5 TO .6 OHM RESISTANCE

X. TEST PICK-UP COIL
  A. DISCONNECT CONNECTOR IN THE DUAL PRIMARY LEAD
  B. USE OHMMETER
  C. CHECK PICK-UP COIL RESISTANCE
  D. RESISTANCE SHOULD BE 400 TO 600 OHMS
  E. CHECK PICK-UP COIL INSULATION
    1. USE OHMMETER AND ONE CONNECTOR LEAD AND GROUND
    2. METER READING SHOULD BE INFINITY

XI. PICK-UP UNIT AIR GAP ADJUSTMENT VERY SIMILAR TO BREAKER POINT ADJUSTMENT

XII. CHECK ADVANCE MECHANISM, DISTRIBUTOR SHAFT, AND BUSHING FOR WEAR

XIII. TEST ALL UNITS OF ELECTRONIC IGNITION SYSTEM, IF PROBLEM STILL EXISTS REPLACE CONTROL UNIT

SUGGESTED READING FOR THE STUDENT:

INFORMATION SHEET, VIII-C-5(IS), "ELECTRONIC IGNITION SYSTEM," (FORD)

THE NEXT LESSON IS: VIII-C-19(I), "ELECTRONIC IGNITION", (FORD)

INFORMATION SHEET CHRYSLER VIII-C-4(IS)

## ON
## ELECTRONIC IGNITION SYSTEM

SUBJECT: Electronic Ignition System

INTRODUCTORY INFORMATION:

The breaker-point ignition has been steadily improved and is an excellent system. However, regular periodic service is required to maintain satisfactory ignition performance. Of all the breaker-point ignition components, the breaker-points have the shortest service life. Of course, spark plugs eventually wear out, but the coil, condenser, and ballast resistor have been improved to the point that they should virtually last the life of the car.

In an engine equipped with breaker-point ignition, there is a slight but continuous change in ignition timing over the life of the points. This is because the contact gap closes and timing starts to retard as a result of rubbing-block wear. As the contact gap closes, the dwell in a breaker-point ignition system is also affected.

Engine performance can be maintained as the points wear by resetting the timing or adjusting the contact gap if the dwell is noticeably off. However, even when the breaker-points are kept properly adjusted, they will deteriorate in normal usage due to metal transfer caused by arcing across the points, oxidation, and erosion. Eventually, this will cause misfiring.

When the contacts deteriorate to the point where they cause misfiring, they should be replaced. When an engine begins to misfire, it also causes spark plug deterioration and shortens plug life considerably. Unfortunately, the average owner does not have tuneup performed often enough to prevent or, for that matter, to correct misfiring.

With the electronic ignition system, periodic distributor service will be a thing of the past since the breaker-points have been replaced by electronic components and circuitry.

GENERAL INFORMATION:

The distributor housing, the advance mechanism, the rotor, and the distributor cap are the same for the electronic ignition and the conventional breaker-point ignition. Both systems use the same type ignition coil and spark plugs. A dual ballast resistor is used. With the exception of the drive and advance mechanisms the components inside the electronic distributor are new. The pick-up unit and reluctor have physically replaced the cam and breaker-points.

The pick-up and reluctor do the same basic job that the cam and breaker-points do but they do it quite differently. A condenser is no longer required.

The pick-up unit consists of a permanent magnet and a coil that is wound around a pole piece. The pole piece is an extension of the mounting bracket and is attached to the permanent magnet. Because of the arrangement, the pick-up unit resembles a horseshoe type magnet with the reluctor end of the pole piece acting as one of the poles.

The reluctor is a gear like component that is attached to the distributor shaft in the same position as the cam in a breaker-point ignition. The reluctor is not a magnet but it does provide a better magnetic path than air. In other words, it is capable of reducing reluctance (resistance to magnetic flow) and this is the reason for calling it a reluctor.

In a very general way, the reluctor and the pick-up unit do electrically what the cam and rubbing block do mechanically in a breaker-point ignition. Although the electronic distributor components replace the cam and breaker-points, they operate quite differently. For one thing, the pick-up unit is not a set of points, and there must be no contact between the reluctor and the pick-up unit.

A short review of the breaker-point system will help to understand how the reluctor and pick-up unit work. In a breaker-point system, the current flowing through the primary winding of the ignition coil is interrupted when the breaker-points are opened by the rotating cam. The collapsing magnetic field in the ignition coil primary induces enough voltage in the ignition coil secondary to fire the plugs.

In the electronic ignition system a permanent magnet in the pick-up unit provides a magnetic field from the pole piece to the permanent magnet itself. This magnetic field passes through the coil that is wound around the pole piece. The magnetic field is relatively weak because the air gap between the pole piece and the magnet does not provide a good magnetic path between the two.

As a tooth of the reluctor approaches the pick-up, it provides a better path than the air gap and the strength of the magnetic field in the pick-up is increased. Increasing the field strength at the pick-up coil induces a positive voltage at one terminal of the coil. It should be understood that this voltage is induced as a result of the changing (increasing) field strength and is not caused by physical movement of the field or the pick-up coil. The positive voltage continues to build until the reluctor tooth is exactly opposite the pole piece.

As soon as the reluctor tooth passes the pole piece, the air gap starts to increase and the field strength begins to decrease. The decreasing field strength through the coil winding induces a negative voltage at the same terminal of the coil winding. Again, the voltage is induced by the change (reduction) in field strength. No voltage is induced in the pick-up coil unless the reluctor is moving. The rapid increase and decrease of the magnetic field as the rotating reluctor teeth approach and pass the pole piece is what induces the positive then the negative voltage.

The induced voltage is very small. It is just a tiny electrical signal that is fed into the electronic control unit. The function of the signal voltage induced in the pick-up unit is not the same as that of the contacts in a breaker-point ignition which open and interrupt the primary current in the ignition coil. The pick-up voltage is a precisely timed signal. It triggers the electronic circuitry in the control unit, and in turn this controls the interruption of the current flowing through the primary windings of the ignition coil.

In the electronic ignition system, battery current flows through the primary winding of the ignition coil and then through the control unit which is grounded. This maintains current flow in the ignition coil primary winding pretty much the same as the closed contacts do in a breaker-point ignition. The control unit remains "on" or activated and current flows through the primary coil windings as long as a negative voltage from the pick-up is not applied to it.

When the reluctor passes the pole piece, and the pick-up voltage turns negative, it deactivates or "turns off" the control unit circuitry. At this point, current cannot flow through the control unit to ground, and therefore the current through the ignition coil primary windings is interrupted. Like in all induction coil-ignition systems, this interruption of the current flow in the primary circuit induces enough voltage in the secondary winding of the ignition coil to fire the spark plug.

The control unit determines electronically how long the ignition coil primary current is allowed to flow before it is interrupted. In other words, it determines the dwell in the electronic system. Since the control unit circuitry is sealed and has no moving parts, the dwell cannot be changed. The reluctor and the pick-up unit determine ignition timing. The control unit determines dwell. However, it takes both of them working together to time the interruption of the ignition coil primary current and the firing of the plugs.

There is no reason to use a dwell meter when testing or checking an electronic ignition system. Dwell will be correct unless the control unit has been damaged, and this possibility can be easily and quickly checked out with an electronic ignition tester. On the other hand, the usual tachometer and timing light will operate just as well with this system as they will with a breaker-point system.

The ballast resistor for the electronic system plays a dual role. On the one side is the half-ohm ballast resistor that is the same as in a breaker-point system. It maintains constant primary current with variations in engine speed. This protects the ignition coil against high current flow at low engine speed. This ballast resistor is bypassed when cranking, to apply full battery voltage to the coil.

The other side of the dual unit is a five-ohm resistor. It protects the control unit by limiting current flow in the electronic part of the circuit. In a breaker-point ignition, the condenser helps the coil develop higher voltage because it speeds up the collapse of the magnetic field. It also increases ignition point life because it reduces arcing as the contacts open. The condenser is not needed in the electronic ignition because there are no points and the collapse of the field in the ignition coil primary is controlled by the electronic circuitry in the control unit.

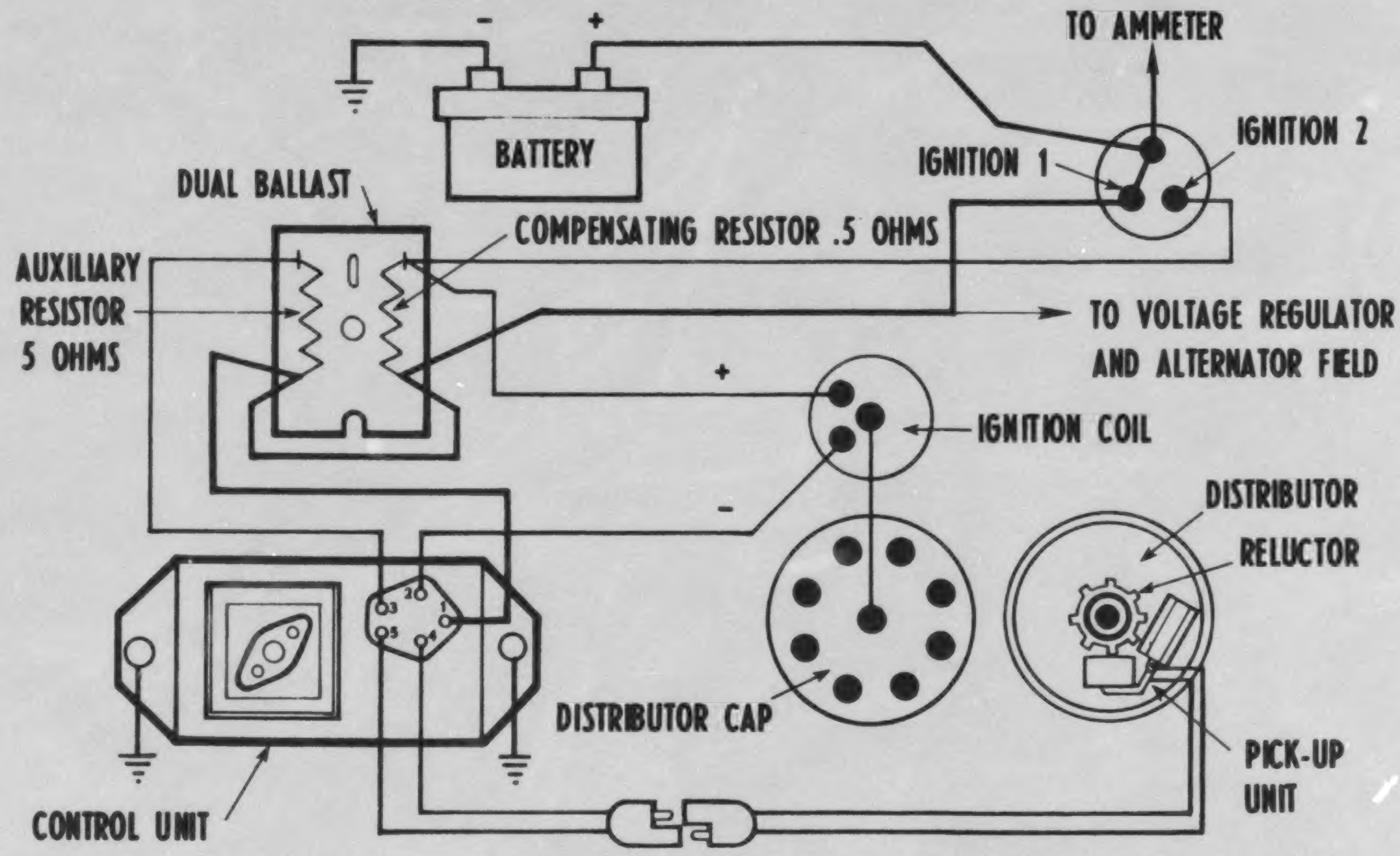
Learn to use the tester available in the shop. Study the instructions which are included with the tester.

If performance problems exist, the first thing to check on the ignition system are the rotor and distributor cap for cracks or corroded terminals. Hairline cracks are sometimes difficult to see; therefore, look the cap and rotor over very carefully.

Visually inspect the secondary ignition cables and check their performance with an ohmmeter or an ignition oscilloscope. Then check the spark plugs and regap or replace them if necessary.

Check the control unit. With the ignition switch off, remove the screw and disconnect the wiring harness from the control unit. Connect tester between the control unit and the wiring harness. This is to put the tester in the ignition system circuit. Turn the ignition switch to the "on" position; engine is not to be started. Take readings from tester indicator.

# CHRYSLER ELECTRONIC IGNITION SYSTEM



-
+
TO AMMETER
BATTERY
IGNITION 1
IGNITION 2
DUAL BALLAST
COMPENSATING RESISTOR .5 OHMS
AUXILIARY RESISTOR 5 OHMS
TO VOLTAGE REGULATOR AND ALTERNATOR FIELD
+
IGNITION COIL
-
DISTRIBUTOR
RELUCTOR
2
3
1
5
4
DISTRIBUTOR CAP
PICK-UP UNIT
CONTROL UNIT

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-10(S)

**TASK:** TEST AND SERVICE ELECTRONIC IGNITION SYSTEM

**AIM:**

1. THE STUDENT WILL BE ABLE TO DIAGNOSE, DETERMINE MALFUNCTIONS OF AN ELECTRONIC IGNITION SYSTEM, AND PIN POINT TROUBLE AREAS; USING THE RECOMMENDED PROCEDURES, TEST EQUIPMENT, AND TOOLS.
2. THE STUDENT WILL BE ABLE TO REPAIR AND SERVICE AN ELECTRONIC IGNITION SYSTEM PUTTING IT BACK INTO OPERATION ACCORDING TO SPECIFICATIONS; USING THE PROPER PROCEDURES, PARTS, TOOLS, AND EQUIPMENT.

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVERS, DROP LIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** JOB AND TASK SHEETS, VIII-C-10(J)

**REFERENCES:**
AUTOMECHANICS, PP. 292-294
AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436
INFORMATION SHEET, VIII-C-10(IS)

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENTS MUST HAVE READ THE REFERENCES AND STUDIED THE JOB AND TASK SHEETS, STUDENTS MUST HAVE SATISFACTORILY COMPLETED JOBS ON THE BREAKER POINT SYSTEM.

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. JOB PREPARATION
3. TEST PROCEDURES AND SETUP
4. FOLLOW SPECIFICATIONS AND PROCEDURES
5. HOLD ALL ADJUSTMENTS TO SPECIFICATIONS
6. MAINTAIN TOOLS AND EQUIPMENT IN GOOD WORKING CONDITION
7. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE
8. MAINTAIN CRAFTSMANLIKE STANDARDS OF WORK
9. MAINTAIN SAFE WORKING HABITS

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE DISTRIBUTOR HOUSING, ADVANCE MECHANISM, ROTOR, AND CAP ARE

THE SAME FOR THE ELECTRONIC IGNITION SYSTEM AS THE BREAKER POINT SYSTEM.

THE COIL AND SPARK PLUGS HAVE NOT BEEN CHANGED. THEREFORE, SERVICE PROCEDURES FOR THESE TWO PARTS ARE THE SAME. INFORMATION FOR THESE PARTS WILL NOT BE REPEATED IN THIS LESSON.

INSIDE THE DISTRIBUTOR THE DRIVE AND ADVANCE MECHANISMS HAVE NOT BEEN CHANGED.

NO LONGER ARE BREAKER POINTS USED; THEY HAVE BEEN REPLACED BY ELECTRONIC COMPONENTS AND CIRCUITRY.

WHEN WORKING WITH THE ELECTRONIC IGNITION SYSTEM IT IS IMPERATIVE THAT ALL SAFETY MEASURES BE OBSERVED. RESPECT THE ELECTRICITY THAT FLOWS THROUGH THIS SYSTEM.

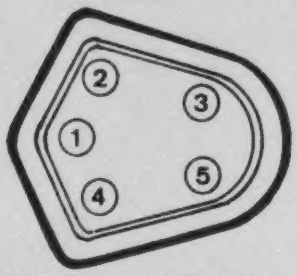
MAKE SURE THAT VOLTMETER AND OHMMETER ARE CORRECTLY CALIBRATED BEFORE MAKING TESTS.

---

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS VIII-C-1(J) |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. INSPECT BATTERY | AS IN PRECEDING TASKS |
| 4. CHECK PRIMARY WIRES | 1. AT IGNITION COIL<br>a. GOOD CONDITION<br>b. TIGHT AT TERMINALS<br>2. AT BALLAST RESISTOR<br>a. GOOD CONDITION<br>b. TIGHT AT TERMINALS |
| 5. ADJUST AIR GAP | 1. BETWEEN THE RELUCTOR TOOTH AND PICK-UP COIL TOOTH<br>2. REMOVE DISTRIBUTOR CAP<br>3. ROTATE DISTRIBUTOR SHAFT UNTIL ONE RELUCTOR TOOTH IS DIRECTLY OPPOSITE PICK-UP COIL TOOTH<br>4. LOOSEN PICK-UP COIL HOLD DOWN SCREW<br>5. SELECT .008" NON-FERROUS FEELER GAUGE<br>6. INSERT GAUGE BETWEEN RELUCTOR TOOTH AND PICK-UP COIL TOOTH |

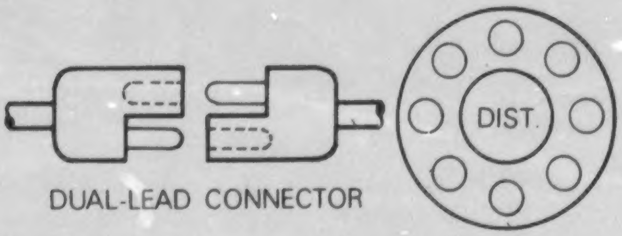
| | |
|---|---|
| | 7. ADJUST PICK-UP COIL SO THAT .008" FEELER GAUGE IS SNUG<br>8. TIGHTEN PICK-UP COIL HOLD DOWN SCREW<br>9. RECHECK AIR GAP<br>10. REPLACE DISTRIBUTOR CAP |
| 6. CHECK SECONDARY CIRCUIT | SAME AS CONVENTIONAL IGNITION SYSTEM |
| 7. PREPARE FOR IGNITION SYSTEM CHECK | 1. TURN OFF IGNITION SWITCH<br>2. DISCONNECT BATTERY<br>NOTE: SAFETY PRECAUTION AGAINST DAMAGE TO SYSTEM FOR METER HOOK UP<br>3. REMOVE THE MULTI-WIRE CONNECTOR FROM CONTROL UNIT<br>4. TURN CONNECTOR OVER TO EXPOSE CAVITIES<br>5. CHECK CONNECTOR CAVITIES FOR NUMBERS |



MULTI-WIRE CONNECTION

| | |
|---|---|
| 8. TEST PICK-UP COIL | 1. CONNECT OHMMETER TO MULTI-WIRE CONNECTOR CAVITIES 4 AND 5<br>2. CHECK OHMMETER READING<br>NOTE: OHMMETER SHOULD INDICATE BETWEEN 350 TO 550 OHMS. IF READING IS HIGHER OR LOWER THAN SPECIFICATIONS |

3. DISCONNECT DUAL-LEAD CONNECTOR ON LEAD FROM DISTRIBUTOR



4. REMOVE OHMMETER LEADS FROM CAVITIES 4 AND 5
5. CONNECT OHMMETER TO DUAL-LEAD CONNECTOR TO DISTRIBUTOR

NOTE: RESISTANCE SHOULD READ BETWEEN 350 TO 550 OHMS. IF READING IS NOT TO SPECIFICATIONS REPLACE PICK-UP COIL

NOTE: IF READING IS WITHIN LIMITS PERFORM SECOND TEST

6. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND
7. LEAVE SECOND OHMMETER LEAD ATTACHED TO CONNECTOR

NOTE: OHMMETER IS TO SHOW AN OPEN CIRCUIT. IF THE OHMMETER SHOWS A READING PICK-UP COIL MUST BE REPLACED

8. REMOVE THE OHMMETER LEADS FROM GROUND AND CONNECTOR
9. CONNECT OHMMETER LEADS TO DUAL CONNECTOR BACK TO CONTROL UNIT
10. DETERMINE CONDITION OF WIRING HARNESS

9. TEST ELECTRONIC CONTROL GROUND CIRCUIT

1. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND
2. CONNECT SECOND OHMMETER LEAD TO

CONTROL UNIT CONNECTOR PIN NO. 5

NOTE: OHMMETER IS TO SHOW CONTINUITY BETWEEN GROUND AND CONNECTOR PIN

NOTE: IF THERE IS NO CONTINUITY

3. LOOSEN THE CONTROL UNIT MOUNTING BOLTS
4. SPRAY BOLTS, FIRE WALL UNDER CONTACT AREA, BACKSIDE OF MOUNTING BRACKETS WITH A GOOD CONTACT CLEANER
5. TIGHTEN BOLTS
6. RECHECK GROUND

NOTE: IF CONTINUITY IS STILL NOT EVIDENT

7. REPLACE CONTROL UNIT
8. RECHECK GROUND

NOTE: IF CONTINUITY STILL DOES NOT EXIST

9. CHECK GROUND BETWEEN FIREWALL AND ENGINE
10. CHECK GROUND BETWEEN FIREWALL AND CHASSIS

CAUTION: DURING THE TESTING OF THE ELECTRONIC CONTROL GROUND CIRCUIT MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION OR THE BATTERY IS DISCONNECTED

NOTE: USING VOLTMETER CHECK AND NOTE BATTERY VOLTAGE - MINIMUM 12 VOLTS. THEN REMOVE MULTI-WIRING CONNECTOR FROM CONTROL UNIT IN PREPARATION FOR CAVITY-BY-CAVITY CHECK TO TEST THE WIRING HARNESS AND ITS CONNECTIONS

10. TEST WIRING HARNESS

1. CAVITY BY CAVITY
2. TURN IGNITION TO ON POSITION
3. CONNECT VOLTMETER TO NEGATIVE LEAD TO GOOD GROUND
4. CONNECT VOLTMETER POSITIVE LEAD

TO CAVITY NO. 1 IN WIRING HARNESS

NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE, ALL ACCESSORIES OFF. IF DIFFERENT, CHECK CIRCUIT

5. HOOK POSITIVE LEAD OF VOLTMETER TO HARNESS CONNECTOR NO. 2

NOTE: VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE WITH ALL ACCESSORIES OFF. IF DIFFERENT, CHECK THE CIRCUIT

6. CONNECT POSITIVE LEAD OF VOLTMETER TO FINAL HARNESS CONNECTOR CAVITY IN THIS TEST NO. 3

NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE IF DIFFERENT, CHECK THE CIRCUIT

NOTE: THE WIRING HARNESS CHECK IS NOW COMPLETE. HARNESS CONNECTORS NOS. 1, 2, AND 3 ARE TESTED WITH A VOLTMETER WITH IGNITION SWITCH "ON", AND CAVITIES NOS. 4 AND 5 (WHICH CHECK OUT THE PICK UP COIL AND CONTROL UNIT) ARE TESTED WITH AN OHMMETER WITH THE IGNITION SWITCH OFF"

11. BALLAST RESISTOR TEST

1. HOOK UP OHMMETER AND MEASURE EACH SIDE OF THE BALLAST IN TURN
2. COMPENSATING (COIL) SIDE SHOULD READ BETWEEN .50 AND .80 OHMS
3. THE AUXILIARY (CONTROL UNIT) SIDE READING SHOULD BE BETWEEN 4.75 AND 5.75 OHMS

NOTE: IF NEITHER ONE OF THESE READING IS OBTAINED, REPLACE THE BALLAST

NOTE: THE COIL MAY BE TESTED IN THE SAME MANNER AS A CONVENTIONAL COIL, VIII-B-2(S)

| | |
|---|---|
| 12. IGNITION COIL TEST | 1. PRIMARY RESISTANCE ON A CHRYSLER PRESTOLITE COIL SHOULD BE BETWEEN 1.6 AND 1.79 OHMS<br>2. ON A CHRYSLER ESSEX COIL, PRIMARY RESISTANCE SHOULD BE BETWEEN 1.41 AND 1.62 OHMS<br>3. SECONDARY RESISTANCE ON CHRYSLER PRESTOLITE COILS SHOULD BE BETWEEN 9,400 AND 11,700 OHMS<br>4. ON A CHRYSLER ESSEX, SECONDARY RESISTANCE SHOULD BE BETWEEN 8,000 AND 11,200 OHMS<br>NOTE: REPLACE IGNITION COIL IF NEITHER ONE OF THESE READINGS IS OBTAINED |
| 13. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION
2. FURNISH STUDENT WITH JOB SHEET, VIII-C-10(J) AND TASK SHEETS

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

1. PUT STUDENTS ON THEIR OWN TO PERFORM TASKS
2. PERFORMANCE TESTS

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REVIEW TEST PROCEDURES FROM JOB VIII-C-10(J)
2. EMPHASIZE IMPORTANCE OF AVAILABLE BATTERY VOLTAGE
3. EMPHASIZE IMPORTANCE OF STEP BY STEP TEST PROCEDURE
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ WIRING DIAGRAMS
5. EMPHASIZE IMPORTANCE OF IGNITION "OFF" AND "ON" POSITIONS
6. EMPHASIZE IMPORTANCE OF CLEAN AND TIGHT ELECTRICAL CONNECTIONS

SUGGESTED READING FOR STUDENT:

AUTOMECHANICS, PP. 292-294

AUTOMOTIVE ENCYCLOPEDIA, PP. 434-436
INFORMATION SHEET VIII-C-5(IS)

THE NEXT LESSON IS: VIII-C-11(S), "TEST AND SERVICE ELECTRONIC IGNITION SYSTEM (FORD)"

JOB SHEET CHRYSLER VIII-C-10(J)

# JOB SHEET IN ELECTRONIC IGNITION SYSTEM

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVERS, DROP LIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCE MATERIALS. STUDY JOB AND TASK SHEETS. BE SURE FENDER COVERS ARE IN POSITION ON THE VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT IGNITION SYSTEM PROBLEMS

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-C-10(TS) | PREPARE FOR ELECTRONIC IGNITION SYSTEM TEST |
| VIII-C-10a(TS) | TEST PICK-UP COIL |
| VIII-C-10b(TS) | TEST ELECTRONIC CONTROL GROUND CIRCUIT |
| VIII-C-10c(TS) | TEST WIRING HARNESS |
| VIII-C-10d(TS) | BALLAST RESISTOR TEST |
| VIII-C-10e(TS) | IGNITION COIL TEST |

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

SERVICE STORAGE BATTERY
TEST STORAGE BATTERY
CLEAN WORK STATION

TASK SHEET CHRYSLER VIII-C-10(TS)

**TASK:** PREPARE FOR IGNITION SYSTEM TEST

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, NON-FERROUS FEELER GAUGE, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, CLEANING CHEMICALS-CLEANER AND SILICONE LUBRICANT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. CHECK PRIMARY WIRES AT IGNITION COIL FOR GOOD CONDITION AND TIGHT CONNECTIONS<br>2. CHECK PRIMARY WIRES AT BALLAST RESISTOR FOR GOOD CONDITION AND TIGHT CONNECTIONS |
| 4. ADJUST AIR GAP | 1. REMOVE ALL DUST, DIRT, OIL, AND GREASE FROM AREAS TO BE TESTED<br>2. REMOVE DISTRIBUTOR CAP. ROTATE DISTRIBUTOR SHAFT UNTIL ONE RELUCTOR TOOTH IS DIRECTLY OPPOSITE PICK-UP COIL TOOTH<br>3. LOOSEN PICKUP COIL HOLD DOWN SCREW<br>4. SELECT .008" NON FERROUS FEELER GAUGE<br>5. INSERT FEELER GAUGE BETWEEN RELUCTOR TOOTH AND PICKUP COIL TOOTH<br>6. ADJUST PICKUP COIL SO THAT .008" FEELER GAUGE IS SNUG<br>7. TIGHTEN PICKUP COIL HOLD DOWN SCREW<br>8. RECHECK AIR GAP WITH .010" FEELER GAUGE<br>9. REPLACE DISTRIBUTOR CAP |

| STEPS | KEY POINTS |
|---|---|
| | ◆ 10. TEST SECONDARY CIRCUIT, SAME CHECK AS CONVENTIONAL IGNITION SYSTEM |
| 5. PREPARE FOR IGNITION SYSTEM CHECK | 1. TURN OFF IGNITION SWITCH |
| | 2. DISCONNECT BATTERY GROUND CABLE |
| | NOTE: SAFETY PRECAUTION AGAINST DAMAGE TO SYSTEM FOR METER HOOK UP |
| | 3. REMOVE MULTI-WIRE CONNECTOR FROM CONTROL UNIT |
| | 4. TURN CONNECTOR OVER TO EXPOSE CAVITIES |
| | 5. CHECK CONNECTOR CAVITIES FOR NUMBERS |

TASK SHEET CHRYSLER VIII-C-10a(TS)

**TASK:** TEST PICKUP COIL

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-1b(TS) |
| 4. PICKUP COIL TEST | 1. CONNECT OHMMETER LEAD PROBES TO CONNECTOR CAVITIES NO. 4 AND NO. 5<br>2. CHECK OHMMETER READING<br>NOTE: OHMMETER SHOULD INDICATE BETWEEN 350 TO 550 OHMS. IF READING IS HIGHER OR LOWER THAN SPECICATIONS<br>3. DISCONNECT DUAL-LEAD CONNECTOR COMING FROM DISTRIBUTOR<br>4. REMOVE OHMMETER LEADS FROM CAVITIES NO. 4 AND 5<br>5. CONNECT OHMMETER LEADS TO DUAL-LEAD CONNECTOR<br>NOTE: RESISTANCE SHOULD READ BETWEEN 350 TO 550 OHMS. IF READING IS NOT TO SPECIFICATIONS, REPLACE PICKUP COIL<br>NOTE: IF READING IS WITHIN LIMITS, PERFORM SECOND TEST<br>6. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND<br>7. LEAVE SECOND OHMMETER LEAD ATTACHED TO CONNECTOR<br>NOTE: OHMMETER SHOULD SHOW AN OPEN CIRCUIT. IF THE OHMMETER |

| STEPS | KEY POINTS |
|---|---|
| | SHOWS A READING, PICKUP COIL MUST BE REPLACED |
| | 8. REMOVE OHMMETER LEADS FROM THE GROUND AND CONNECTOR |
| | 9. CONNECT OHMMETER LEADS, TO DUAL CONNECTOR, BACK TO CONTROL UNIT |
| | 10. INSPECT CONDITION OF WIRING HARNESS |

TASK SHEET CHRYSLER VIII-C-10b(TS)

| | |
|---|---|
| TASK: | TEST ELECTRONIC CONTROL GROUND CIRCUIT |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVERS, SEAT COVERS, CONTACT CLEANER (SPRAY CAN) |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-1a(TS) |
| 4. TEST ELECTRONIC GROUND CIRCUIT | 1. CONNECT ONE OHMMETER LEAD TO A GOOD GROUND<br>2. CONNECT SECOND OHMMETER LEAD TO CONTROL UNIT CONNECTOR PIN NO. 5<br>NOTE: OHMMETER IS TO SHOW CONTINUITY BETWEEN GROUND AND CONNECTOR PIN<br>NOTE: IF THERE IS NO CONTINUITY<br>3. LOOSEN THE CONTROL UNIT MOUNTING BOLTS<br>4. SPRAY BOLTS, FIREWALL UNDER CONTACT AREA, BACKSIDE OR MOUNTING BRACKETS WITH A GOOD CONTACT CLEANER<br>5. TIGHTEN BOLTS<br>6. RECHECK GROUND<br>NOTE: IF CONTINUITY IS STILL NOT EVIDENT<br>7. REPLACE CONTROL UNIT<br>8. RECHECK GROUND<br>NOTE: IF CONTINUITY STILL DOES NOT EXIST<br>9. CHECK GROUND BETWEEN FIREWALL AND ENGINE |

10. CHECK GROUND BETWEEN FIREWALL AND CHASSIS

CAUTION: DURING THE TESTING OF THE ELECTRONIC CONTROL GROUND CIRCUIT MAKE SURE THE IGNITION SWITCH IS IN THE OFF POSITION OR THE BATTERY IS DISCONNECTED

NOTE: USING VOLTMETER CHECK AND NOTE BATTERY VOLTAGE - MINIMUM 12 VOLTS. THEN REMOVE MULTI-WIRING CONNECTOR FROM CONTROL UNIT IN PREPARATION FOR CAVITY-BY-CAVITY CHECK TO TEST THE WIRING HARNESS AND ITS CONNECTIONS

TASK SHEET CHRYSLER VIII-C-10c(TS)

**TASK:** TEST WIRING HARNESS

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVERS, SEAT COVERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-A-1a(TS)<br>AS IN VIII-A-1b(TS) |
| 4. TEST WIRING HARNESS | 1. CAVITY BY CAVITY |
| | 2. TURN IGNITION SWITCH TO ON POSITION |
| | 3. CONNECT VOLTMETER NEGATIVE LEAD TO CAVITY NO. 1 IN WIRING HARNESS |
| | 4. CONNECT VOLTMETER POSITIVE LEAD TO CAVITY NO. 1 IN WIRING HARNESS |
| | NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE, ALL ACCESSORIES OFF. IF DIFFERENT, CHECK CIRCUIT |
| | 5. ATTACH POSITIVE LEAD OF VOLTMETER TO HARNESS CONNECTOR NO. 2 |
| | 6. NEGATIVE LEAD TO GROUND |
| | NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE WITH ALL ACCESSORIES OFF, IF DIFFERENT CHECK CIRCUIT |
| | 7. LEAVE NEGATIVE LEAD GROUNDED |
| | 8. ATTACH POSITIVE LEAD OF VOLTMETER TO FINAL HARNESS CONNECTOR CAVITY NO. 3 |
| | NOTE: AVAILABLE VOLTAGE SHOULD BE WITHIN ONE VOLT OF BATTERY VOLTAGE. IF DIFFERENT, CHECK OUT THE CIRCUIT |

| STEPS | KEY POINTS |
|---|---|
|  | NOTE: THE WIRING HARNESS CHECK IS NOW COMPLETE. HARNESS CONNECTORS NOS. 1, 2, AND 3 ARE TESTED WITH A VOLTMETER WITH IGNITION SWITCH IN "ON" POSITION AND CAVITIES NOS. 4 AND 5 (WHICH CHECK OUT THE PICKUP COIL) ARE TESTED WITH AN OHMMETER WITH IGNITION SWITCH "OFF" |

TASK SHEET CHRYSLER VIII-C-10d(TS)

| | |
|---|---|
| TASK: | BALLAST RESISTOR TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, FENDER COVERS, AND SEAT COVERS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREARE FOR TESTING | AS IN VIII-A-1b(TS) |
| 4. BALLAST RESISTOR TEST | 1. HOOK UP OHMMETER AND MEASURE EACH SIDE OF BALLAST RESISTOR IN TURN<br>2. COMPENSATING (COIL) SIDE SHOULD READ BETWEEN .50 AND .80 OHMS<br>3. AUXILIARY (CONTROL UNIT) SIDE READING SHOULD BE BETWEEN 4.75 AND 5.57 OHMS<br>NOTE: IF NEITHER ONE OF THE READINGS IS OBTAINED, REPLACE BALLAST |

TASK SHEET CHRYSLER VIII-C-10e(TS)

| | |
|---|---|
| TASK: | TEST IGNITION COIL |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, FENDER COVERS, SEAT COVERS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, PARTS CLEANER AND RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | SEE VIII-A-1(J) |
| 4. IGNITION COIL TEST | NOTE: PRIMARY RESISTANCE ON A CHRYSLER PRESTOLITE COIL SHOULD BE BETWEEN 1.6 AND 1.79 OHMS, ON A CHRYSLER ESSEX COIL, PRIMARY RESISTANCE SHOULD BE BETWEEN 1.41 AND 1.62 OHMS. SECONDARY RESISTANCE ON CHRYSLER PRESTOLITE COILS SHOULD BE BETWEEN 9,400 AND 11,700 OHMS<br>NOTE: IF NEITHER ONE OF THESE READINGS IS OBTAINED, REPLACE THE COIL |

INSTRUCTOR'S PLAN FORD VIII-C-19(I)
INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | ELECTRONIC IGNITION |
| AIM: | 1. THE STUDENT WILL BE ABLE TO RECITE THE NAMES OF THE ELECTRONIC IGNITION SYSTEM PARTS.<br>2. THE STUDENT WILL BE ABLE TO DISCUSS AND EXPLAIN THE FUNCTIONAL OPERATION OF THE ELECTRONIC IGNITION SYSTEM COMPONENTS.<br>3. THE STUDENT WILL BE ABLE TO DESCRIBE THE TESTING PROCEDURES FOR THE ELECTRONIC IGNITION SYSTEM. |
| TEACHING AIDS: | DISPLAY OF ELECTRONIC IGNITION PARTS |
| MATERIALS: | |
| REFERENCES: | INFORMATION SHEET, FORD VIII-C-5(IS) "ELECTRONIC IGNITION"<br>AUTOMECHANICS, PP. 289-293<br>AUTOMOTIVE ENCYLOPEDIA, PP. 433-435 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE SATISFACTORILY COMPLETED ALL ASSIGNMENTS AND TASKS FOR THE BREAKER POINT IGNITION SYSTEM. THE STUDENT MUST HAVE READ AND STUDIED THE REFERENCES FOR THIS LESSON. |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THIS IGNITION SYSTEM IS COMMONLY REFERRED TO AS THE FORD SOLID STATE IGNITION SYSTEM.

THE VOLT-OHMMETER TESTER IS THE ONLY INSTRUMENT REQUIRED TO TEST THIS SYSTEM.

THE SYSTEM IS ALL NEW INCLUDING AN OIL FILLED COIL AND A SPARK PLUG GAP OF .044".

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. MODULE | 1. THE CONTROLLING UNIT FOR THE SYSTEM<br>2. CASE IS ALUMINUM, HEAT SINK<br>3. ELECTRONIC PARTS ARE ASSEMBLED IN THE CASE AND TESTED |

4. THE ELECTRONIC PARTS ARE SEALED IN EPOXY AND SAND
   - a. TO WITHSTAND HEAT
   - b. TO WITHSTAND SHOCK
5. SEVEN LEADS EXTEND FROM THE CASE
   - a. 4 LEADS IN ONE CLUSTER
     - (1) 2 TO IGNITION SWITCH AND RESISTOR
     - (2) 2 TO DISTRIBUTOR
   - b. 3 LEADS IN SECOND CLUSTER
     - (1) 1 LEADS TO CONNECTION BETWEEN RESISTOR AND BAT TERMINAL OF COIL
     - (2) 1 LEADS TO DEC TERMINAL OF COIL
     - (3) 1 LEADS TO DISTRIBUTOR
6. THE SEVEN WIRES ARE THE MOST VULNERABLE PART OF THE MODULE
7. THE MODULE CANNOT BE REPAIRED, IT MUST BE REPLACED IN THE EVENT IT GOES OUT

### B. DISTRIBUTOR

1. NO CHANGE IN:
   - a. SHAFT
   - b. GEAR
   - c. WEIGHTS
   - d. SPRINGS
   - e. CAP
   - f. ROTOR
2. SIMILAR IN APPEARANCE TO BREAKER POINT DISTRIBUTOR
3. CHANGES:
   - a. PRIMARY LEAD ENTRY INTO DISTRIBUTOR HOUSING SLOT INSTEAD OF HOLE
   - b. ROD FOR DIAPHRAGM ASSEMBLY HAS BEEN CHANGED
   - c. CAM HAS BEEN REPLACED BY A SLEEVE AND PLATE ASSEMBLY
   - d. UPPER AND LOWER BREAKER PLATE ASSEMBLY HAS BEEN REPLACED BY A BASE PLATE MOUNTED TO THE BASE CASTING
   - e. POINTS AND CONDENSER HAVE BEEN REMOVED

C. ARMATURE

1. REPLACES BREAKER CAM
2. RESEMBLES RIMLESS WHEEL WITH SPOKES PROTRUDING OUT
3. THERE IS ONE SPOKE (POLE) FOR EACH CYLINDER OF THE ENGINE
4. IT IS SECURED TO SLEEVE AND PLATE ASSEMBLY BY A SMALL ROLL PIN AFTER ALL SLOTS HAVE BEEN ALIGNED
5. IT ROTATES WITH THE DISTRIBUTOR SHAFT
6. IT MAY BE REMOVED BY LIFTING UPWARD ON IT
7. IT IS THE MOVEMENT OF THESE POLES PAST THE CORE OF THE MAGNETIC PICK-UP ASSEMBLY THAT SIGNALS THE MODULE TO TURN OFF THE PRIMARY IGNITION CURRENT

D. MAGNETIC PICK-UP ASSEMBLY

1. MAY BE REFERRED TO AS STATOR ASSEMBLY
2. MOUNTED ON BASE PLATE AND SECURED WITH A FINE WIRE RETAINING RING
3. IT HAS THREE LEADS ATTACHING IT TO THE ELECTRONIC MODULE
4. LOCATED IN DISTRIBUTOR WHERE POINTS USED TO BE
5. MADE UP OF A PERMANENT MAGNET AND A PICK-UP COIL CONSISTING OF MANY WINDINGS OF FINE WIRE

E. COIL

1. OIL FILLED RATHER THAN TAR FILLED
2. TALLER THAN TAR FILLED COIL
3. MAY BE ALL BLUE IN COLOR OR MAY HAVE BLACK BODY AND BLUE TOWER
4. TOWER TERMINALS ARE LABELED:
   a. BAT (BATTERY)
   b. DEC (DISTRIBUTOR ELECTRONIC CONTROL)

F. IGNITION OPERATION

1. IGNITION SWITCH ON
2. CIRCUIT SWITCHING TRANSISTOR IN MODULE IS TURNED ON
3. PRIMARY CURRENT FLOWS THROUGH BALLAST RESISTOR
4. CURRENT FLOWS THROUGH IGNITION COIL PRIMARY WINDING

5. CURRENT THEN FLOWS THROUGH MODULE TRANSISTOR
6. CURRENT FINALLY REACHES GROUND AT DISTRIBUTOR HOUSING
7. ELECTRICAL SIGNALS ARE GENERATED AS ARMATURE POLES APPROACH AND PASS MAGNETIC PICK-UP COIL CORE
    a. AS POLE APPROACHES CORE GENERATED SIGNAL IS POSITIVE
    b. WHEN POLE AND CORE ARE EXACTLY OPPOSITE EACH OTHER SIGNAL IS ZERO
    c. AS POLE PASSES CORE GENERATED SIGNAL IS NEGATIVE
8. ZERO SIGNAL DIRECTS MODULE TO TURN OFF
    a. THIS BREAKS PRIMARY CIRCUIT
    b. STOPS FLOW OF CURRENT IN IGNITION COIL PRIMARY WINDINGS AND MAGNETIC FIELD BREAKS DOWN
    c. HIGH VOLTAGE IS INDUCED IN IGNITION COIL SECONDARY WINDINGS
    d. HIGH VOLTAGE IS DELIVERED TO THE CORRECT SPARKPLUG THROUGH THE DISTRIBUTOR CAP AND ROTOR
9. CONTROL UNIT TIMING CIRCUIT SENSES THAT THE SPARK PLUG HAS FIRED
10. SWITCHING TRANSISTOR OF MODULE IS AGAIN TURNED ON FOR THE NEXT FIRING CYCLE
11. DWELL PERIOD VARIES WITH ENGINE RPM AND CANNOT BE CONTROLLED

G. 7 LEADS IDENTIFICATION

1. RED
    1. CARRIES IGNITION VOLTAGE TO ELECTRONIC MODULE
    2. TURNS ON ELECTRONIC MODULE SWITCHING TRANSISTOR
    3. ALLOWS CURRENT TO FLOW IN PRIMARY CIRCUIT

2. WHITE
    1. SAME AS RED LEAD
    2. BY PASS BALLAST RESISTOR DURING CRANKING

| | | |
|---|---|---|
| 3. ORANGE<br>PURPLE | | TRANSMITS SIGNALS FROM DISTRIBUTOR MAGNETIC PICK-UP ASSEMBLY TO ELECTRONIC MODULE |
| 4. BLUE | | PROVIDES CIRCUIT PROTECTION FOR ELECTRONIC MODULE |
| 5. GREEN | 1. | RECEIVES PRIMARY CURRENT FROM COIL |
| | 2. | MODULE THEN TRANSMITS PRIMARY CURRENT TO DISTRIBUTOR THROUGH BLACK LEAD |
| 6. BLACK | 1. | GROUND FOR PRIMARY CIRCUIT |
| | 2. | SWITCHED ON AND OFF BY ELECTRONIC MODULE |
| H. SYSTEM CHECKING PROCEDURES | 1. | MAKE SURE BATTERY IS IN GOOD CONDITION AND CHARGED |
| | 2. | INSPECT SYSTEM FOR LOOSE CONNECTIONS |
| | 3. | PERFORM CRANKING COIL TEST<br>a. SCOPE LOOK FOR 20 KV MIN<br>NOTE: IF CRANKING COIL VOLTAGE IS PRESENT TROUBLE IS IN SECONDARY CIRCUIT<br>b. OR PERFORM SPARK INTENSITY TEST |
| | 4. | DISCONNECT 4 WIRE CONNECTOR AND 3 WIRE CONNECTOR |
| I. MODULE BIAS TEST | 1. | USE VOLTMETER |
| | 2. | CONNECT VOLTMETER TO PIN NO. 3 OF 4 WIRE CONNECTOR (RED) AND GOOD GROUND |
| | 3. | TURN IGNITION ON |
| | 4. | VOLTAGE IS TO BE BATTERY VOLTAGE<br>NOTE: IF VOLTAGE IS LESS THAN BATTERY REPAIR VOLTAGE FEED WIRE TO MODULE |
| J. BATTERY SOURCE TEST | 1. | COIL IS NOT TO BE DISCONNECTED |
| | 2. | CONNECT VOLTMETER BETWEEN BAT TERMINAL OF IGNITION COIL AND A GOOD GROUND |
| | 3. | CONNECT A JUMPER WIRE BETWEEN DEC TERMINAL OF COIL AND A GOOD GROUND |

4. ALL LIGHTS AND ACCESSORIES ARE TO BE OFF
5. TURN IGNITION SWITCH ON

   NOTE: VOLTMETER READING IS TO BE BETWEEN 4.9 AND 7.9 VOLTS FOR PRIMARY CIRCUIT FROM BATTERY TO COIL TO BE SATISFACTORY

   IF READING IS LESS THAN 4.9 VOLTS CHECK PRIMARY WIRING FOR:

   a. WORN INSULATION
   b. BROKEN STRANDS
   c. LOOSE OR CORRODED TERMINALS

   IF READING IS GREATER THAN 7.9 VOLTS REPLACE RESISTANCE WIRE

### K. CRANKING TEST

1. USE VOLTMETER
2. CONNECT METER BETWEEN PIN NO. 1 IN 4 WIRE CONNECTOR AND A GOOD GROUND (WHITE)
3. VOLTAGE READING IS TO BE 8 TO 12 VOLTS

   NOTE: IF READING IS NOT 8 TO 12 VOLTS REPAIR VOLTAGE FEED TO MODULE

### L. STARTING CIRCUIT TEST

1. SET VOLTMETER ON THE 2.5 VOLT SCALE
2. CONNECT VOLTMETER BETWEEN THE TWO PARALLEL BLADES IN THE 3 WIRE CONNECTOR (ORANGE AND PURPLE)
3. METER NEEDLE IS TO OSCILLATE WHILE ENGINE IS BEING CRANKED

### M. MAGNETIC PICK-UP ASSEMBLY TEST

1. CONNECT OHMMETER BETWEEN THE TWO PARALLEL BLADES IN THE 3 WIRE CONNECTOR (ORANGE AND PURPLE)
2. METER READING MUST BE 400 TO 800 OHMS
3. CONNECT OHMMETER BETWEEN THIRD BLADE OF THREE WIRE CONNECTOR (BLACK) AND A GOOD GROUND ON THE DISTRIBUTOR HOUSING
4. READING ON OHMMETER FOR BLACK WIRE SHOULD BE ZERO
5. CONNECT OHMMETER BETWEEN EITHER PARALLEL BLADE AND A GOOD GROUND

6. OHMMETER READING FOR ORANGE OR PURPLE WIRE MUST BE GREATER THAN 70,000 OHMS

   NOTE: IF ANY TEST FAILS THE MAGNETIC PICK-UP ASSEMBLY IS NOT FUNCTIONING PROPERLY AND MUST BE REPLACED

### N. IGNITION COIL TEST

1. TO BE TESTED SEPARATELY FROM OTHER COMPONENTS OF THE SYSTEM
2. PRIMARY RESISTANCE MUST BE 1 TO 2 OHMS
3. SECONDARY RESISTANCE MUST BE 7,000 TO 13,000 OHMS
4. ANY FURTHER TESTS MUST BE MADE ON A COIL TESTER

   NOTE: FOLLOW MANUFACTURER'S INSTRUCTIONS FOR CONVENTIONAL COIL TEST

   NOTE: IF ANY TEST DOES NOT HOLD WITHIN SPECIFICATIONS REPLACE PRIMARY RESISTANCE WIRE OR COIL

### O. SHORT TEST

NOTE: IF RESISTANCE FROM CONNECTOR PIN NO. 5 (RED) TO GROUND IS LESS THAN 4 OHMS PERFORM SHORT TEST

1. CHECK BETWEEN DEC TERMINAL OF IGNITION COIL AND GROUND FOR SHORT
2. CHECK IGNITION COIL PRIMARY WINDING FOR SHORT
3. CAUTION: USE ONLY RECOMMENDED TEST PROCEDURES WHEN CHECKING ALTERNATOR OUTPUT, OTHERWISE THE IGNITION SYSTEM CAN BE DAMAGED

   CAUTION: WHEN PERFORMING SPARK INTENSITY TEST AT SPARK PLUGS USE ONLY SPARK PLUG WIRES 2, 3, 4, AND 6 ON A SIX CYLINDER ENGINE AND SPARK PLUG WIRES 2, 3, 4, 6, AND 7 FOR AN EIGHT CYLINDER ENGINE.

   USING WIRES 1 AND 5 FOR A SIX OR 1 AND 8 FOR AN EIGHT CAN CAUSE INTERNAL ARCING DAMAGE IN THE DISTRIBUTOR

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT IS THE FUNCTION OF THE MODULE IN THE FORD S/S IGNITION SYSTEM?

ANSWER: IT IS THE SYSTEM CONTROL UNIT STOPPING PRIMARY CURRENT FLOW, CAUSING COIL TO PRODUCE HIGH VOLTAGE TO FIRE SPARK PLUGS, AND RECYCLING PROCESS.

2. WHAT IS THE PURPOSE OF THE EPOXY-SAND SEALER IN THE MODULE?

ANSWER: IT PROTECTS THE ELECTRONIC PARTS FROM HEAT AND SHOCK.

3. WHAT PART OF THE MODULE IS THE MOST VULNERABLE TO POSSIBLE TROUBLES?

ANSWER: THE SEVEN WIRES OUTSIDE THE CORE.

4. WHAT CHANGES HAVE BEEN MADE IN THE DISTRIBUTOR SHAFT CAM?

ANSWER: THE CAM HAS BEEN REPLACED BY A SLEEVE AND PLATE ASSEMBLY.

5. WHAT IS THE DISTRIBUTOR ARMATURE?

ANSWER: IT HAS REPLACED THE BREAKER CAM AND RESEMBLES A RIMLESS WHEEL WITH THE SPOKES PROTRUDING OUT. THESE SPOKES ARE CALLED POLES AND THE MOVEMENT OF THESE POLES PAST THE MAGNETIC PICK-UP ASSEMBLY SIGNALS THE MODULE.

6. WHAT PARTS MAKE UP THE MAGNETIC PICK-UP ASSEMBLY?

ANSWER: IT IS MADE UP OF THREE ELECTRICAL LEADS, A PERMANENT MAGNET, AND A PICK-UP COIL WOUND AROUND A CORE.

7. HOW DOES THE FORD S/S COIL DIFFER FROM A CONVENTIONAL COIL?

ANSWER: THE FORD S/S COIL DIFFERS FROM A CONVENTIONAL COIL IN THAT:
   a. IT IS OIL FILLED
   b. IT IS TALLER
   c. IT MAY BE SOLID BLUE IN COLOR OR THE BASE MAY BE BLACK AND THE TOWER BLUE
   d. THE TERMINALS ARE LABELED BAT (BATTERY) AND DEC (DISTRIBUTOR ELECTRONIC CONTROL)

8. WHAT IS THE OPERATION OF THE FORD S/S IGNITION SYSTEM?

ANSWER: a. IGNITION SWITCH ON

b. MODULE CIRCUIT SWITCHING TRANSISTOR TURNED ON
c. PRIMARY CURRENT FLOWS THROUGH BALLAST RESISTOR
d. PRIMARY CURRENT THEN FLOWS THROUGH IGNITION COIL PRIMARY WINDINGS
e. PRIMARY CURRENT THEN FLOWS THROUGH MODULE TRANSISTOR
f. PRIMARY CURRENT FLOWS ON TO DISTRIBUTOR GROUND
g. DISTRIBUTOR ARMATURE TURNS ONE POLE LINING UP WITH PICK-UP COIL CORE AND ZERO SIGNAL IS PRESENT
h. ZERO SIGNAL CAUSES MODULE TO TURN OFF CURRENT IN IGNITION COIL PRIMARY WINDINGS
i. HIGH VOLTAGE IS INDUCED IN IGNITION COIL SECONDARY WINDING
j. HIGH VOLTAGE IS DELIVERED THROUGH DISTRIBUTOR AND ROTOR TO CORRECT SPARK PLUG
k. MODULE SWITCHING TRANSISTOR IS TURNED ON AND NEXT FIRING CYCLE STARTS

9. WHEN IS A MODULE REPLACED?

ANSWER: WHEN ALL OTHER COMPONENTS TEST OUT SATISFACTORY, THE MODULE IS REPLACED.

10. WHEN THE CRANKING TEST INDICATES IGNITION PROBLEM WHAT PART IS REPAIRED OR REPLACED?

ANSWER: IF CRANKING TEST INDICATES IGNITION PROBLEM, THE VOLTAGE FEED TO MODULE IS REPAIRED OR REPLACED.

11. WHAT IS THE ACTION OF THE VOLTMETER DURING THE STARTING CIRCUIT TEST IF NO IGNITION PROBLEM EXISTS AT THIS POINT?

ANSWER: THE VOLTMETER NEEDLE WILL OSCILLATE IF NO IGNITION PROBLEM EXISTS AT THIS POINT.

12. WHICH CONNECTOR IS USED TO TEST THE MAGNETIC PICK-UP ASSEMBLY?

ANSWER: THE THREE WIRE CONNECTOR IS THE TESTING SOURCE FOR THE MAGNETIC PICK-UP ASSEMBLY.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

1. IN THE SHORT TEST IF THE RESISTANCE FROM PIN #5 (RED WIRE) TO A GOOD GROUND IS LESS THAN 4 OHMS, CHECK FOR A SHORT TO GROUND AT THE ___ TERMINAL OF THE IGNITION COIL. DEC ________

## IV. VERIFICATION (CON'T)

| | | |
|---|---|---|
| 2. | THE MAGNETIC PICK-UP ASSEMBLY TEST IS MADE WITH AN ____ METER. | OHM |
| 3. | IN THE IGNITION CRANKING TEST IF THE VOLTAGE READING IS NOT BETWEEN 8 AND 12 VOLTS, THE IGNITION ____ CIRCUIT IS OPEN OR GROUNDED. | BY PASS |
| 4. | IN THE BATTERY SOURCE TEST IF THE VOLTAGE READING IS GREATER THAN 7.9 VOLTS THE ____ WIRE SHOULD BE REPLACED. | RESISTANCE |
| 5. | IN THE MODULE BIAS TEST IF THE VOLTAGE IS ____ THAN BATTERY VOLTAGE, REPAIR THE VOLTAGE FEED WIRE TO THE MODULE. | LESS |
| 6. | IF A PROBLEM IS ENCOUNTERED IN THE ELECTRONIC IGNITION SYSTEM, FIRST MAKE SURE THE BATTERY IS IN A GOOD STATE OF CHARGE AND INSPECT THE ENTIRE SYSTEM FOR ____. | LOOSE CONNECTIONS |
| 7. | ELECTRICAL SIGNALS ARE GENERATED IN THE DISTRIBUTOR BY THE ARMATURE POLES AS THEY APPROACH AND PASS THE ____ OF THE MAGNETIC PICK-UP COIL. | CORE |
| 8. | AS EACH POLE ALIGNS WITH PICK-UP CENTER, THE MODULE SWITCHING TRANSISTOR IS TURNED OFF BY A ____ SIGNAL. | ZERO |
| 9. | THE DWELL PERIOD IN THE FORD SOLID STATE IGNITION SYSTEM NORMALLY ____ WITH ENGINE RPM AND CANNOT BE ALTERED. | VARIES |
| 10. | THE MODULE CASE IS ALSO A ____ SINK. | HEAT |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

I. MODULE
  a. CONTROL UNIT FOR SYSTEM
  b. SEVEN COLOR CODED WIRES
  c. SEALED AGAINST HEAT AND SHOCK

- d. CANNOT BE REPAIRED
- e. CONTROLS ANGLE OF DWELL

II. DISTRIBUTOR
- a. SHAFT, GEAR, WEIGHTS, SPRINGS, CAP AND ROTOR NO CHANGE
- b. CHANGES
  - 1. PRIMARY LEADS ENTER SLOT IN HOUSING
  - 2. DIAPHRAGM ASSEMBLY ROD
  - 3. NO CAM, SLEEVE AND PLATE REPLACES IT
  - 4. BASE PLATE REPLACES UPPER AND LOWER BREAKER PLATE ASEMBLY
  - 5. AN ARMATURE AND MAGNETIC PICK-UP ASSEMBLY ARE IN PLACE OF BREAKER POINTS

III. ARMATURE
- a. RESEMBLES RIMLESS WHEEL
- b. SPOKES ARE POLES
- c. ATTACHED TO SHAFT SLEEVE AND PLATE WITH ROLL PIN
- d. MOVEMENT OF POLES PAST CORE SIGNALS MODULE

IV. MAGNETIC PICK-UP ASSEMBLY
- a. STATOR ASSEMBLY
- b. MOUNTED ON BASE PLATE
- c. MADE UP OF LEADS, MAGNET, COIL, AND CORE

V. COIL
- a. NEW OIL FILLED
- b. BLUE OR BLUE AND BLACK IN COLOR
- c. TALLER THAN TAR FILLED TYPE
- d. TERMINALS LABELED BAT AND DEC

VI. IGNITION OPERATION
- a. CURRENT FLOWS THROUGH BALLAST RESISTOR
- b. CURRENT THEN FLOWS THROUGH COIL PRIMARY WINDINGS
- c. CURRENT NOW FLOWS THROUGH MODULE TRANSISTOR
- d. CURRENT REACHES GROUND AT DISTRIBUTOR HOUSING
- e. ROTOR TURNS MATCHING POLE WITH CORE OF MAGNETIC PICK-UP, SIGNAL BECOMES ZERO
- f. MODULE TURNS OFF PRIMARY CURRENT
- g. HIGH VOLTAGE IS INDUCED IN COIL SECONDARY WINDINGS
- h. HIGH VOLTAGE IS DIRECTED TO SPARK PLUGS THROUGH DISTRIBUTOR CAP AND ROTOR

VII. SYSTEM CHECK
- a. CHECK BATTERY
- b. INSPECT FOR LOOSE CONNECTION
- c. PERFORM CRANKING COIL TEST

VIII. MODULE BIAS TEST
  a. VOLTMETER
  b. USE PIN NO. 3 OF 4 WIRE CONNECTOR AND GROUND
  c. TURN IGNITION ON
  d. REPAIR MODULE VOLTAGE FEED WIRE IF TEST SHOWS LESS THAN BATTERY VOLTAGE

IX. BATTERY SOURCE TEST
  a. LEAVE COIL CONNECTED
  b. VOLTMETER
  c. USE DEC COIL TERMINAL AND GROUND
  d. LIGHTS OFF IGNITION ON
  e. IF READING IS LESS THAN 4.9 VOLTS CHECK OUT PRIMARY WIRING
  f. IF READING IS GREATER THAN 7.9 VOLTS REPLACE RESISTOR WIRE

X. CRANKKING TEST
  a. VOLTMETER
  b. USE PIN # 1 IN 4 WIRE CONNECTOR AND GROUND
  c. IF READING IS NOT 8 TO 12 VOLTS REPAIR VOLTAGE FEED TO MODULE

XI. STARTING CIRCUIT TEST
  a. VOLTMETER SET ON 2.5 VOLT SCALE
  b. USE TWO PARALLEL BLADES OF 3 WIRE CONNECTOR
  c. METER IS TO OSCILLATE IF ALL IS WELL

XII. MAGNETIC PICK-UP ASSEMBLY TEST
  a. OHMMETER
  b. USE TWO PARALLEL BLADES IN THREE WIRE CONNECTOR
  c. READING IS TO BE 400 TO 800 OHMS
  d. CONNECT OHMMETER TO THIRD BLADE AND GROUND ON DISTRIBUTOR HOUSING
  e. READING MUST BE ZERO
  f. CONNECT OHMMETER TO EITHER PARALLEL BLADE AND GROUND
  g. READING MUST BE GREATER THAN 70,000 OHMS
  h. IF ANY TEST FAILS REPLACE MAGNETIC PICK-UP ASSEMBLY

XIII. COIL TEST
  a. SEPARATE FROM ALL OTHER IGNITION PARTS
  b. CHECK PRIMARY AND SECONDARY RESISTANCE
  c. ADDITIONAL TESTS MUST BE MADE ON DISTRIBUTOR TESTER

XIV. SHORT TEST
  a. CHECK BETWEEN DEC TERMINAL OF COIL AND GROUND
  b. CHECK COIL PRIMARY WINDING

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SUGGESTED READING FOR THE STUDENTS:

VIII-C-6(IS), "ELECTRONIC IGNITION," (GM)

THE NEXT LESSON IS: VIII-C-20(I), "ELECTRONIC IGNITION," (GM)

# INFORMATION SHEET
# ON
# ELECTRONIC IGNITION

SUBJECT: Electronic Ignition System

## INTRODUCTORY INFORMATION:

The Ford solid state ignition system contains an electronic module which is the controlling element for the system. The distributor is new and points and condenser have been replaced by an armature and stator. The coil is now oil filled. A volt-ohmmeter tester is the only test equipment needed for the ignition system diagnosis.

Wires for the system are color coded. Battery power is supplied to the module from the ignition switch through the white wire when the engine is cranked. After the engine has started and running, battery power is supplied to the module through the red wire. Distributor signals are received at the module through the orange and purple wires. Primary ignition is received from the coil through the green wire.

Primary ignition current is transmitted to the distributor and ground through the black wire. Ignition system protection is provided by the blue wire.

As the ignition switch is turned on primary current flows through the resistor circuit, to the coil, on to the module and to ground. When the engine is turned over and the distributor shaft rotates there are signals generated by the distributor which cause the module to break the primary current flow. As the module breaks the primary current flow secondary voltage is induced in the coil causing the spark plug to fire. The module timing circuit turns the primary current on again and the coil is energized for the next spark cycle. Dwell measurement is meaningless in this system because dwell varies with engine speed and there is no means of altering or controlling it.

The ignition process for this system is very much like the breaker point system; however, it requires more wiring and equipment. It is much more reliable, accurate, and there is little or no maintenance for the primary ignition system. The system has a secondary output within the ranges of the conventional breaker point system.

The spark plug gap for the electronic ignition system has been changed. It varies from .044" to .054", but for the most part a .044" gap is used. However, to be on the safe side refer to the manufacturer's specifications when performing spark plug service.

## GENERAL INFORMATION:

The module is the heart of the Ford solid state ignition system. The module cannot be repaired. It must be replaced if it becomes defective. The case is made of aluminum and is the heat sink. All parts are assembled in the case and tested. The parts are sealed in the case in a mixture of sand and epoxy. This construction renders the module impervious to shock and temperatures from normal automotive use. The wire leads are the most vulnerable parts of the module.

The new distributor is similar in appearance to the breaker point distributor but it has the following construction differences.

A. The primary wiring hole is now a slot.

B. The diaphragm assembly control rod is different.

C. The cam and advance plate assembly have been replaced by a sleeve and plate assembly.

D. The upper and lower spring loaded base plate assembly has been replaced by a base plate mounted on the base casting. On the base plate the magnetic pick-up assembly has been fitted. The pickup unit is secured to the base plate with a fine wire retaining ring.

E. The center post breaker cam has been replaced by an armature. The armature is secured to the sleeve and plate by aligning slots and inserting a roll pin.

F. The armature can be removed by pulling up on it.

The oil filled coil is blue or has a blue top on it. It is also taller than the tar filled type. Terminals are labeled BAT (battery) and DEC (distributor electronic control). This type coil's output and performance characteristics differ from the old conventional coil.

This new oil filled coil must be tested separate from the other ignition components. It can be tested on any standard coil tester according to manufacturer's specifications.

A volt-ammeter tester or a type that utilizes a knife switch at the battery terminal is not to be used for alternator output test on a vehicle equipped with solid state ignition, for destructive damage can be caused. For alternator output testing on vehicles equipped with the solid state ignition system use the volt-ohmmeter test procedure. However, the system is protected against electrical current produced or used under normal vehicle operating conditions.

As on the breaker point system the spark intensity test is used for the solid state system to isolate ignition problems. Follow the procedure:

1. Remove the coil to distributor high tension lead from the distributor tower

2. Connect an auxiliary starter switch into the starting circuit

3. Turn the ignition switch to the "on" position

4. Hold the distributor end of the high tension lead with high tension pliers about 3/16" from cylinder head or a good ground

5. Crank the engine over with the auxiliary starter switch

   NOTE: If the spark is good the trouble is in the primary circuit. If no spark or it is weak check the coil to distributor high tension lead for good condition.

   NOTE: No test is to be made at the module terminals at this time. Disconnect the three-way and four-way connectors at the electronic module. Install a new module. If the trouble is not corrected, reinstall the original module and check the remaining ignition system components.

   CAUTION: The grease on the engine harness connector is not to be removed as this grease is used as a corrosion inhibitor.

The test to determine that the module is receiving correct battery voltage is referred to as the module bias test. Performed as follows:

1. Disconnect the four-way connector at the module

2. Connect a voltmeter between a good ground and pin hole 3 (red lead) of the connector

3. Turn the ignition switch to the "on" position

4. Observe voltmeter reading

   NOTE: If the voltmeter reading is less than battery voltage, repair or replace the voltage feed wire to the module.

Battery to coil test or battery source test is performed as follows:

1. Connect a voltmeter between a good ground and the coil battery terminal. Coil is to remain connected as usual

2. Connect a jumper lead between the coil DEC terminal and a good ground

3. Turn all lights and accessories off

4. Turn the ignition switch to the "on" position

   NOTE: If the voltmeter reading is between 4.9 volts and 7.9 volts, the primary circuit from the battery to the coil is satisfactory.

   NOTE: If the voltmeter reading is less than 4.9 volts:

      a. Check primary wiring for worn insulation, broken strands, or loose and corroded terminals.

b. Check resistance wire for good condition.

NOTE: If the voltmeter reading is greater than 7.9 volts:

a. Verify resistance wire condition.

b. Replace resistance wire.

Cranking circuit test:

1. Connect voltmeter between a good ground and pin hole 1 (white lead) of the four-hole connector
2. Turn ignition switch to "on" position
3. Crank engine over with auxiliary starter switch

   NOTE: If the voltmeter reading is not 8 to 12 volts, repair or replace the voltage lead to the module.

Starting circuit test

1. Connect the voltmeter between a good ground and pin hole 5 (green wire) of the three-hole connector
2. Turn the ignition to the "on" position
3. Crank engine over with auxiliary starter switch

   NOTE: If the voltage reading is no. beween 8 to 12 volts:

   a. Ignition bypass circuit is open or grounded from either the starter solenoid, the ignition switch to pin hole 5 (green wire), or primary coil connection.

   b. Repair or replace leads as required.

Magnetic pickup or stator test

1. Disconnect the three-wire connector at the distributor pigtail
2. Connect a DC voltmeter on the 2.5 volt scale between the two parallel blades in the male part of the connector (orange and purple wires)
3. Turn ignition to "on" position
4. Crank the engine over - the meter needle should oscillate
5. Turn off ignition switch
6. Remove voltmeter
7. Connect an ohmmeter between the two parallel blades (orange and purple leads)

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NOTE: This distributor connection should read 400 to 800 ohms.

8. Remove one lead of ohmmeter from a blade and connect it to a good ground
   NOTE: Resistance between either blade and ground must be greater than 70,000 ohms.

9. Connect ohmmeter between third blade (black lead) and good ground on distributor housing
   NOTE: Resistance between third lead and distributor housing must be "0".
   NOTE: If any one test fails the distributor magnetic pickup (stator assembly) is not functioning properly and should be replaced.
   NOTE: If troubles persist
   a. Remove distributor cap
   b. Visually and by feel check distributor for damages or mis-assembly
      (1) Armature must be sintered
      (2) Armature must be tight on sleeve
      (3) Roll pin securely in position
      (4) Sintered iron stator is not broken
      (5) Armature rotates when engine is cranked over

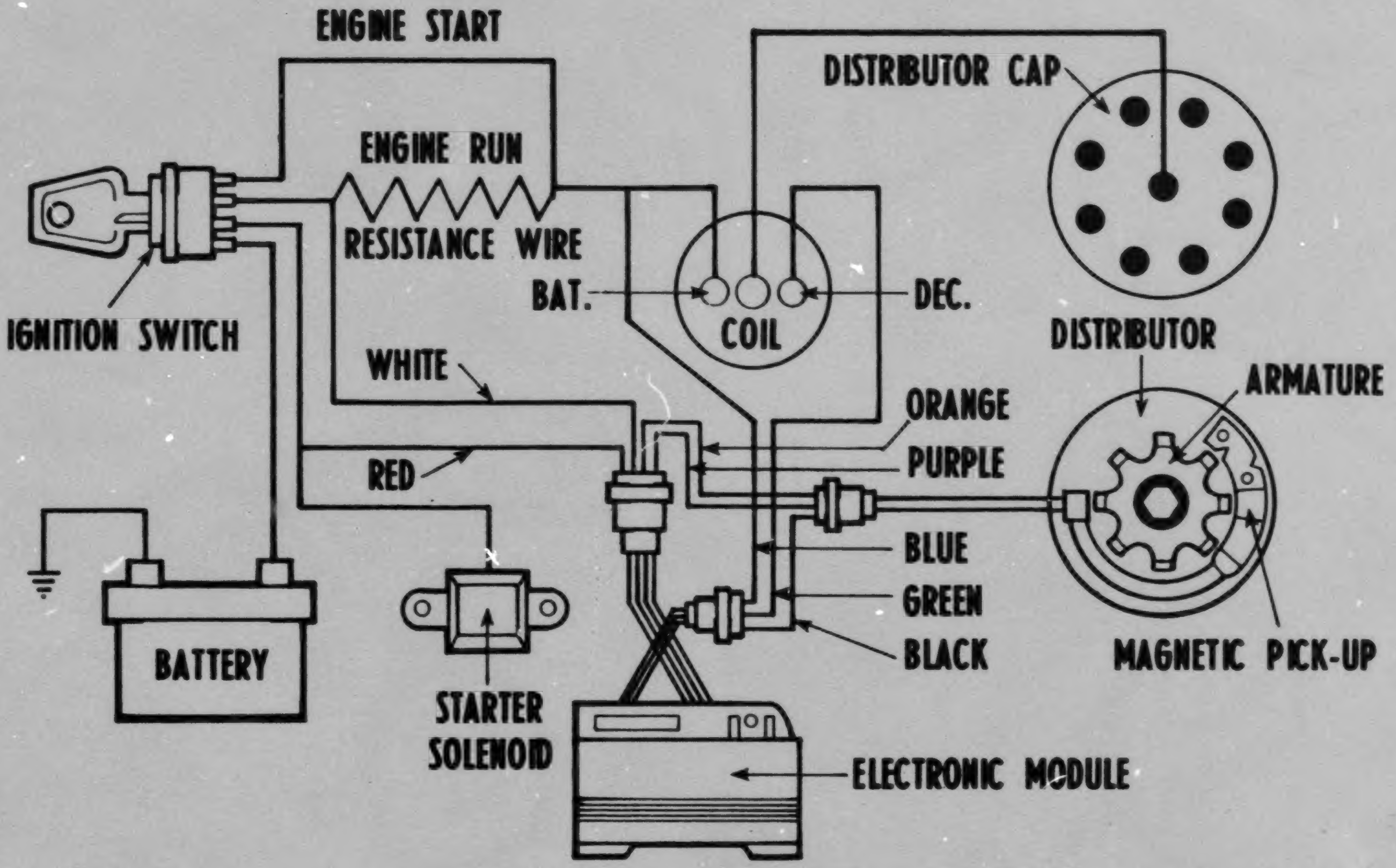
Short or ground test

1. Connect ohmmeter between pin hole 5 (red lead) of the 4 wire connector and a good ground
   NOTE: If the resistance is less than 4 ohms:

2. Check for a short at the DEC terminal of the coil to ground

3. Check primary winding of coil
   NOTE: If resistance reading is out of specifications replace primary wire.

# FORD SOLID STATE IGNITION


ENGINE START
DISTRIBUTOR CAP
ENGINE RUN
RESISTANCE WIRE
BAT.
COIL
DEC.
IGNITION SWITCH
DISTRIBUTOR
WHITE
ARMATURE
ORANGE
PURPLE
RED
BLUE
GREEN
BLACK
BATTERY
STARTER SOLENOID
MAGNETIC PICK-UP
ELECTRONIC MODULE

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VIII-C-5(IS)

VIII-C-11(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** TEST AND SERVICE ELECTRONIC IGNITION SYSTEM (FORD)

**AIM:** THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF FORD'S ELECTRONIC IGNITION SYSTEM, TO DETERMINE NEEDED ADJUSTMENTS, OR REPLACEMENT OF SPECIFIC PARTS OF THE IGNITION SYSTEM; USING THE TOOLS AND TEST EQUIPMENT CALLED FOR IN THE TASK

**TOOLS AND EQUIPMENT:** HAND TOOLS, VOLT-OHMMETER, TEST LEADS, FENDER COVERS, SEAT COVERS, DROP LIGHT, AND INSULATED PLIERS

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** WIRING DIAGRAMS, MANUFACTURER'S REPAIR MANUAL, EXPLODED VIEWS OF COMPONENTS
JOB VIII-C-11(TS) FORD AND TASK SHEETS

**REFERENCES:** AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
MOTOR, NOVEMBER 1974, PP. 25, 26, AND 57
FORD SERVICE MANUALS

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENTS MUST HAVE STUDIED JOB SHEET VIII-C-11(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON IGNITION SYSTEMS AND COMPONENTS

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. OBSERVE SAFETY RULES
3. PREPARATION AND HOOKUP OF TEST EQUIPMENT
4. USE OF TEST EQUIPMENT
5. TEST RESULTS ACCORDING TO SPECIFICATIONS
6. USE OF TOOLS AND EQUIPMENT
7. AN ATTITUDE OF APPRECIATION FOR CUSTOMER'S VEHICLE
8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN ABNORMAL OPERATION IS NOTED IN STARTING AND RUNNING OF A VEHICLE, IT IS NECESSARY TO DETERMINE WHICH SYSTEM IS AT FAULT.
DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF TESTS AND INSPECTIONS WHICH WILL POINT OUT COMPONENTS OF THE AUTOMOTIVE ELECTRICAL SYSTEM THAT MAY BE AT FAULT IN CONTROLLING THE IGNITION SYSTEM. HOOKUP OF TEST EQUIPMENT, TESTING PROCEDURES, AND RE-

COMMENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS<br>2. RAISE HOOD AND INSTALL FENDER COVERS |
| 2. PRELIMINARY CHECK | 1. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT IGNITION COIL<br>2. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT DISTRIBUTOR<br>3. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT MODULE |
| 3. SPARK INTENSITY TEST AT COIL | 1. DISCONNECT THE HIGH-TENSION WIRE FROM CENTER OF DISTRIBUTOR TOWER<br>2. HOLD WIRE (WITH INSULATED PLIERS) ABOUT ¼ INCH AWAY FROM A GOOD GROUND<br>3. CRANK ENGINE<br>NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP REGULARLY<br>4. REPLACE HIGH TENSION WIRE IN DISTRIBUTOR TOWER<br>5. REMOVE SPARK PLUG WIRE FROM THE SPARK PLUG<br>6. HOLD WIRE ABOUT ¼ INCH FROM ENGINE GROUND WITH A PAIR OF INSULATED PLIERS<br>CAUTION: NEVER PULL NO. 1 OR NO. 5 ON THE 6 CYLINDER ENGINE; NO. 2 OR NO. 4 ON A V6 ENGINE; NO. 1 OR NO. 3 ON A 4 CYLINDER ENGINE; OR NO. 1 OR NO. 8 ON AN 8 CYLINDER ENGINE. IT CAN CAUSE DAMAGE TO THE DISTRIBUTOR BY INTERNAL ARCING<br>7. CRANK THE ENGINE<br>NOTE: THERE SHOULD BE A STRONG |

| | |
|---|---|
| | BLUE SPARK ARCING THE GAP |
| NO START TEST<br>4. PREPARE BATTERY | 1. REMOVE BATTERY TERMINAL LEADS<br>2. THOROUGHLY CLEAN AND SERVICE BATTERY POSTS AND LEAD CONNECTORS<br>3. INSTALL BATTERY TERMINAL LEADS AND TIGHTEN SECURELY |
| 5. MODULE BIAS TEST | NOTE: POWER TO OPERATE<br>1. TURN IGNITION KEY ON<br>2. CONNECT VOLTMETER NEGATIVE LEAD TO A GOOD GROUND<br>3. CONNECT VOLTMETER POSITIVE LEAD<br>4. PROBE TO SOCKET NO. 3 ON HARNESS SIDE<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR -0.1 VOLT |
| 6. BATTERY SOURCE TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO GOOD GROUND<br>2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR -0.1 VOLT |
| 7. CRANKING TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO GOOD GROUND<br>2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 1 ON HARNESS SIDE<br>NOTE: BATTERY VOLTAGE SHOULD BE 8 TO 12 VOLTS |
| 8. STARTING CIRCUIT TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO A GOOD GROUND<br>2. CONNECT VOLTMETER POSITIVE TEST LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE<br>NOTE: BATTERY VOLTAGE SHOULD BE 8 TO 12 VOLTS D. C. |

9. DISTRIBUTOR HARDWARE TEST

1. CONNECT VOLTMETER NEGATIVE TEST LEAD PROBE TO HARNESS SOCKET NO. 7
2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO HARNESS SOCKET NO. 8
3. CRANK ENGINE

   CAUTION: LIMIT CRANKING TIME TO 15 SECOND INTERVALS

   NOTE: ANY WIGGLE OF THE NEEDLE ON VOLTMETER DIAL IS OK, OR AT LEAST ½ VOLT READING ON A.C. SCALE

10. STATOR TEST

1. TURN IGNITION KEY TO OFF POSITION
2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 7 AND SOCKET NO. 8

   NOTE: RESISTANCE SHOULD BE 400 TO 800 OHMS
3. CONNECT OHMMETER PROBES TO SOCKET NO. 7 AND TO ENGINE GROUND

   NOTE: RESISTANCE SHOULD BE ZERO OHMS
4. CONNECT OHMMETER PROBES TO SOCKET NO. 7 AND TO ENGINE GROUND

   NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS
5. CONNECT OHMMETER PROBES TO SOCKET NO. 8 AND TO ENGINE GROUND

   NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS

11. COIL TEST

1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 3 AND TO IGNITION COIL TOWER

   NOTE: RESISTANCE SHOULD BE 7,000 TO 13,000 OHMS
2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 5 AND 4

   NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS

| | |
|---|---|
| 12. SHORT TEST | 1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKETS NO. 5 AND TO ENGINE GROUND<br>NOTE: RESISTANCE SHOULD BE MORE THAN 4.0 OHMS |
| 13. RESISTANCE WIRE TESTS | 1. CONNECT OHMMETER TEST LEAD PROBES TO SOCKETS NO. 3 AND NO. 4<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS<br>CAUTION: DO NOT USE THE VOLT-AMP TEST METHOD OR TEST PROCEDURE OR ANY TEST EQUIPMENT WHEREIN A SWITCH IS USED AT THE BATTERY TERMINAL |
| 14. CLEAN WORK STATION | AS IN PREVIOUS TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION
2. STUDENTS TO USE JOB AND TASK SHEETS
3. RETEACH WHEN THE NEED ARISES
4. ASK QUESTIONS ABOUT STEPS AND KEY POINTS AS STUDENTS PERFORM TASKS

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

1. STUDENTS TO BE PLACED ON THEIR OWN TO PERFORM JOB
2. USE PERFORMANCE TEST
3. CHECK STUDENTS FOR ACCURACY OF RESULTS
4. POST THE RESULTS ON PROGRESS CHART

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE THE IMPORTANCE OF USING THE CORRECT TEST INSTRUMENT FOR THE JOB
2. EMPHASIZE THE IMPORTANCE OF KNOWING WHICH SPARK PLUG WIRE NOT TO REMOVE FOR ENGINE RUNNING TESTS
3. EMPHASIZE SAFE WORK HABITS
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ SCHEMATIC DIAGRAMS

5. EMPHASIZE THE IMPORTANCE OF FOLLOWING STEP BY STEP TESTING PROCEDURES
6. REPEAT AREAS TO BE TESTED FROM STAGE II OF THE LESSON
7. DRILL STUDENTS ON KEY POINTS FOR EACH TEST

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 289-294
AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
MOTOR, NOVEMBER, 1974, PP. 25, AND 56-57
FORD MOTOR CO. SERVICE MANUALS, IGNITION SERVICE

THE NEXT LESSON IS: VIII-C-12(S), "TEST & SERVICE ELECTRONIC (H. E. I.) IGNITION SYSTEM (GENERAL MOTORS)"

JOB SHEET FORD VIII-C-11(J)

# JOB SHEET
# IN
# ELECTRONIC IGNITION SYSTEM

| | | |
|---|---|---|
| JOB: | TEST ELECTRONIC SYSTEM | |
| MATERIALS: | CLEAN RAGS | |
| TOOLS AND EQUIPMENT: | FENDER COVERS, SEAT COVERS, DROP LIGHT, HAND TOOLS, VOLTMETER, OHMMETER, INSULATED PLIERS, TEST LEAD PROBES, AND SPARK PLUG ADAPTERS | |
| GENERAL INSTRUCTION: | BEFORE STARTING THIS JOB, READ REFERENCE MATERIAL. STUDY JOB AND TASK SHEETS. BE SURE FENDER AND SEAT COVERS ARE IN POSITION ON VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT<br>BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT IGNITION SYSTEM PROBLEMS | |
| PROCEDURE AND/OR TASKS: | VIII-C-10(J) | PREPARE FOR IGNITION SYSTEM TEST CHRYSLER |
| | VIII-C-11(TS) | SPARK INTENSITY TEST |
| | VIII-C-11a(TS) | MODULE BIAS TEST |
| | VIII-C-11b(TS) | BATTERY SOURCE TEST |
| | VIII-C-11c(TS) | DISTRIBUTOR HARDWARE TEST |
| | VIII-C-11d(TS) | STATOR TEST |
| | VIII-C-11e(TS) | COIL TEST |
| | VIII-C-11f(TS) | SHORT TEST |
| | VIII-C-11g(TS) | RESISTANCE WIRE TEST |
| | | CLEAN WORK STATION |

TASK SHEET FORD VIII-C-11(TS)

**TASK:** TEST SPARK INTENSITY

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLT-METERS, 20,000 VOLT-OHM RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROP LIGHT, INSULATED PLIERS, SEAT COVERS, AND FENDER COVERS

**TASK BREAKDOWN:**

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| | |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT IGNITION COIL<br>2. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT DISTRIBUTOR<br>3. CHECK FOR LOOSE, DISCONNECTED, OR CORRODED TERMINALS AT THE MODULE |
| 4. SPARK INTENSITY TEST AT COIL | 1. DISCONNECT HIGH TENSION WIRE FROM CENTER OF DISTRIBUTOR TOWER<br>2. HOLD WIRE (WITH INSULATED PLIERS) ABOUT $\frac{1}{4}$ INCH AWAY FROM A GOOD GROUND<br>3. CRANK ENGINE OVER<br>NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP REGULARLY<br>4. REPLACE HIGH TENSION WIRE IN DISTRIBUTOR TOWER<br>5. REMOVE SPARK PLUG WIRE FROM A SPARK PLUG<br>6. HOLD WIRE ABOUT $\frac{1}{4}$ INCH FROM THE ENGINE GROUND WITH A PAIR OF INSULATED PLIERS<br>CAUTION: NEVER PULL NO. 1 OR NO. 5 ON THE SIX CYLINDER ENGINE; NO. 2 OR NO. 4 ON THE V6 ENGINE; NO. 1 OR NO. 3 |

ON THE FOUR CYLINDER ENGINE; NO. 1 OR NO. 8 ON THE EIGHT CYLINDER ENGINE

7. CRANK THE ENGINE OVER

NOTE: THERE SHOULD BE A STRONG BLUE SPARK ARCING THE GAP

TASK SHEET FORD VIII-C-11a(TS)

**TASK:** MODULE BIAS TEST

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLT-OHMMETER, 20,000 OHM/VOLT RATING POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROP LIGHT, INSULATED PLIERS, FENDER COVERS, AND SEAT COVERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARATION FOR TESTING | AS PER VIII-C-11(TS) |
| 4. MODULE BIAS TEST | 1. TURN IGNITION KEY ON<br>2. CONNECT VOLTMETER NEGATIVE LEAD TO A GOOD GROUND<br>3. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 3 ON HARNESS<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT<br>4. TURN IGNITION KEY OFF |

TASK SHEET FORD VIII-C-11b(TS)

TASK: BATTERY SOURCE TEST

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, VOLT METER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, DROP LIGHT, INSULATED PLIERS, FENDER COVERS, AND SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-C-11(TS) |
| 4. BATTERY SOURCE TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD TO GOOD GROUND<br>2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 5 ON HARNESS SIDE<br>3. TURN IGNITION SWITCH "ON"<br>NOTE: BATTERY VOLTAGE SHOULD BE + OR - 0.1 VOLT |

TASK SHEET FORD VIII-C-11c(TS)

TASK: TEST DISTRIBUTOR HARDWARE

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT BATTERY, INSULATED PLIERS, REMOTE STARTER CONTROL SWITCH, DROP LIGHT, FENDER COVERS, SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-11(TS) |
| 4. DISTRIBUTOR HARDWARE TEST | 1. CONNECT VOLTMETER NEGATIVE TEST LEAD PROBE TO HARNESS SOCKET NO. 7<br>2. CONNECT VOLTMETER POSITIVE LEAD PROBE TO SOCKET NO. 8<br>3. CONNECT REMOTE STARTER CONTROL SWITCH IN STARTING CIRCUIT<br>a. ATTACH ONE LEAD TO SOLENOID BATTERY TERMINAL<br>b. REMOVE IGNITION START AND TRANSMISSION NEUTRAL SWITCH WIRES FROM STARTER SOLENOID TERMINALS<br>c. ATTACH OTHER REMOTE STARTER CONTROL SWITCH LEAD TO START TERMINAL ON STARTER SOLENOID<br>CAUTION: NEUTRAL SWITCH WIRE MUST BE DISCONNECTED WHEN USING REMOTE STARTER CONTROL ON AUTOMATIC TRANSMISSION EQUIPPED VEHICLES<br>4. TURN IGNITION SWITCH "ON"<br>5. CRANK ENGINE OVER, USING REMOTE STARTER CONTROL SWITCH<br>CAUTION: LIMIT CRANKING TIME TO 15 SECOND INTERVALS |

| STEPS | KEY POINTS |
|---|---|
| | 6. OBSERVE VOLTMETER READING<br>NOTE: WITH THE ENGINE CRANKING, THE METER NEEDLE SHOULD OSCILLATE. ANY WIGGLE OF THE NEEDLE IS OK, OR AT LEAST ONE-HALF VOLT READING ON A.C. SCALE |
| | 7. TURN IGNITION SWITCH "OFF" |

TASK SHEET FORD VIII-C-11d(TS)

**TASK:** TEST STATOR

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, INSULATED PLIERS, REMOTE STARTER CONTROL SWITCH, DROP LIGHT, FENDER COVERS, SEAT COVERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | AS PER VIII-C-11(TS) |
| 4. TEST STATOR | 1. TURN IGNITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBES TO SOCKET NO. 7 AND TO SOCKET NO. 8<br>3. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 400 TO 800 OHMS<br>4. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 6<br>5. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND<br>6. OBSERVE OHMMETER READING<br>NOTE: READING SHOULD BE ZERO<br>7. CONNECT OHMMETER PROBE TO SOCKET NO. 7<br>8. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND<br>9. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS<br>10. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 8<br>11. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND |

| STEPS | KEY POINTS |
|---|---|
| | 12. OBSERVE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE MORE THAN 70,000 OHMS |

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TASK SHEET FORD VIII-C-11e(TS)

**TASK:** COIL TEST

**JOB:** TEST ELECTRONIC IGNITION SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, INSULATED PLIERS, FENDER COVERS, SEAT COVER, CLEAN RAG, DROP LIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-11(TS) |
| 4. COIL TEST | 1. TURN IGNITION SWITCH TO OFF POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 3<br>3. CONNECT OTHER OHMMETER TEST LEAD PROBE TO IGNITION COIL TOWER<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 7,000 TO 13,000 OHMS<br>5. CONNECT OHMMETER TEST LEAD TO SOCKET NO. 4<br>6. CONNECT OTHER OHMMETER TEST LEAD PROBE TO SOCKET NO. 5<br>7. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS |

TASK SHEET FORD VIII-C-11f(TS)

TASK: SHORT TEST

JOB: TEST ELECTRONIC IGNITION SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: DROP LIGHT, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF VOLT BATTERY, INSULATED PLIERS, HAND TOOLS, FENDER COVERS, SEAT COVER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS IN VIII-C-11(TS) |
| 4. SHORT TEST | 1. TURN INGITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 5<br>3. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND ON ENGINE<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE MORE THAN 4.0 OHMS |

TASK SHEET FORD VIII-C-11g(TS)

TASK: TEST RESISTANCE WIRE

JOB: TEST ELECTRONIC IGNITION SYSTEM

TOOLS AND MATERIALS: DROP LIGHT, HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, POWERED BY ONE AND ONE-HALF BATTERY, FENDER COVERS, SEAT COVERS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-11(TS) |
| 4. RESISTANCE WIRE TEST | 1. TURN IGNITION SWITCH TO "OFF" POSITION<br>2. CONNECT OHMMETER TEST LEAD PROBE TO SOCKET NO. 3<br>3. CONNECT OTHER OHMMETER TEST LEAD PROBE TO SOCKET NO. 4<br>4. NOTE OHMMETER READING<br>NOTE: RESISTANCE SHOULD BE 1.0 TO 2.0 OHMS<br>CATUION: DO NOT USE VOLT-AMP. METHOD OF TEST PROCEDURE OR ANY TEST EQUIPMENT WHEREIN A KNIFE SWITCH IS USED AT THE BATTERY TERMINAL |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-20(I)

SUBJECT: ELECTRONIC IGNITION (GM)

AIM:
1. THE STUDENT WILL BE ABLE TO RECITE THE NAMES OF THE ELECTRONIC IGNITION SYSTEM PARTS.
2. THE STUDENT WILL BE ABLE TO DISCUSS AND EXPLAIN THE FUNCTIONAL OPERATION OF THE ELECTRONIC IGNITION SYSTEM COMPONENTS.
3. THE STUDENT WILL BE ABLE TO DESCRIBE THE TESTING PROCEDURES FOR THE ELECTRONIC IGNITION SYSTEM.

TEACHING AIDS: DISPLAY OF ELECTRONIC IGNITION PARTS

MATERIALS:

REFERENCES: INFORMATION SHEET, GM VIII-C-6(IS)
"ELECTRONIC IGNITION"
AUTOMECHANICS, PP. 289-293
AUTOMOTIVE ENCYCLOPEDIA, PP. 433-435

PREREQUISITE EXPERIENCE OF THE LEARNER: THE STUDENT MUST HAVE SATISFACTORILY COMPLETED ALL ASSIGNMENTS AND TASKS FOR THE BREAKER POINT IGNITION SYSTEM. THE STUDENT MUST HAVE READ AND STUDIED THE REFERENCES FOR THIS LESSON.

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

GENERAL MOTORS IGNITION SYSTEM, HIGH ENERGY IGNITION SYSTEM (HEI), DIFFERS FROM OTHER SYSTEMS BECAUSE THE COIL IS BUILT INTO THE DISTRIBUTOR CAP. NO HIGH TENSION COIL WIRE OR RESISTOR WIRE IS USED. SPARK PLUG WIRES ARE RETAINED; HOWEVER, THEY ARE 1 MM LARGER IN DIAMETER DUE TO ADDITION OF INSULATION TO WITHSTAND 35,000 VOLTS. THE THICKER INSULATION HELPS TO PREVENT VOLTAGE LOSS.

AS IN OTHER SYSTEMS, THE POINTS AND CONDENSER HAVE BEEN ELIMINATED. NEW AND INCLUDED IN THE DISTRIBUTOR IS A NOISE SUPPRESSOR FOR THE RADIO.

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### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENT TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. DISTRIBUTOR | 1. DISTRIBUTOR HOUSING SAME AS BREAKER POINT SYSTEM<br>2. DISTRIBUTOR HOUSING CONTAINS<br>a. ELECTRONIC MODULE |

   - b. RADIO NOISE SUPPRESSION CAPACITOR
   - c. MAGNETIC PICK-UP ASSEMBLY
   - d. TIMER CORE
- 3. DISTRIBUTOR CAP
   - a. HOUSE COIL
   - b. SPARK PLUG HIGH TENSION LEADS
- 4. CONVENTIONAL ROTOR IS STILL IN USE

B. COIL

- 1. IN DISTRIBUTOR CAP
- 2. NO HIGH TENSION LEAD
- 3. CENTER CARBON BUTTON IN DISTRIBUTOR CAP MAKES CONTACT WITH COIL FOR HIGH VOLTAGE TO DISTRIBUTOR
- 4. THERE ARE THREE LEADS ON COIL
   - a. ON ONE SIDE IS A GROUND LEAD
   - b. IN THE CENTER IS THE BATTERY LEAD
   - c. ON OUTSIDE OPPOSITE GROUND IS TACH LEAD
   - d. ALL LEADS ARE PLUGGED INTO DISTRIBUTOR CAP

C. MODULE

- 1. SOLID-STATE UNIT
- 2. CONTAINS FIVE COMPLETE CIRCUITS
   - a. SPARK TRIGGER
   - b. SWITCHES
   - c. CURRENT LIMITER
   - d. DWELL CONTROL
   - e. DISTRIBUTOR PICK-UP

D. MAGNETIC PICK-UP ASSEMBLY

- 1. MADE UP OF:
   - a. PICK-UP COIL PLATE
   - b. PERMANENT MAGNET
   - c. PICK UP COIL
   - d. POLE PLATE WITH INTERNAL TEETH
- 2. IT IS MOUNTED OVER THE MAIN BEARING ON THE DISTRIBUTOR HOUSING
- 3. MADE TO ROTATE BY VACUUM CONTROL UNIT, PROVIDING VACUUM ADVANCE

E. TIMING CORE

- 1. MOUNTED ON DISTRIBUTOR SHAFT
- 2. MADE TO ROTATE WITH SHAFT
- 3. ALSO MADE TO ROTATE ON SHAFT BY CONVENTIONAL ADVANCE WEIGHTS, THUS CENTRIFUGAL ADVANCE IS PROVIDED

4. HAS EXTERNAL TEETH TO MATCH POLE PLATE AND NUMBER OF ENGINE CYLINDERS

F. HEI THEORY OF OPERATION

1. PRIMARY CURRENT FLOWS TURNING ON MODULE
2. MAGNETIC PICK-UP ASSEMBLY PERMANENT MAGNET
3. MAGNETIC FIELD PASSES THROUGH PICKUP COIL
4. MAGNETIC FIELD IS WEAK WHEN POLE PIECE AND TIMER CORE TEETH ARE NOT MATCHED BECAUSE OF AIR GAP
5. POLE PIECE TEETH AND TIMER CORE TEETH MATCH AIR GAP IS SMALL AND MAGNETIC FIELD BECOMES STRONG
6. WHEN TEETH PASS MAGNETIC FIELD STRENGTH DECREASES AND MAGNETIC FIELD DECREASES SUDDENTLY
7. DECREASED MAGNETIC FIELD REVERSES CURRENT IN PICK-UP COIL
8. THE SUDDEN REVERSAL OF CURRENT SIGNALS THE MODULE TO TURN OFF COIL PRIMARY CURRENT
9. CURRENT STOPS FLOWING IN IGNITION COIL PRIMARY WINDINGS WHICH INDUCES A HIGH VOLTAGE IN THE COIL SECONDARY WINDING

   NOTE: VOLTAGE IN THE HEI SYSTEM IS MUCH HIGHER THAN THE CONVENTIONAL SYSTEM, AS MUCH AS 50,000 VOLTS COMPARED TO 30,000 VOLTS
10. SPARK PLUGS ARE FIRED BY HIGH VOLTAGE

G. HEI TROUBLES

1. APPEAR IN TWO WAYS:
   a. ENGINE WILL NOT START
   b. ENGINE RUNS ROUGH
2. SYSTEM CAN BE CHECKED ON OR OFF THE VEHICLE
3. CHECK SYSTEM OFF THE VEHICLE
   a. USE DISTRIBUTOR TESTER
   b. ADD ON TO TESTER
      (1) DISTRIBUTOR PULSE AMPLIFIER
      (2) OHMMETER
      (3) COIL TESTER

c. ALWAYS FOLLOW MANUFACTURER'S INSTRUCTIONS

H. CHECK HEI SYSTEM

1. CHECK BATTERY FOR FULL CHARGE
2. CHECK WIRING CONNECTORS FOR TIGHT AND CLEAN
3. CHECK SPARK PLUG HIGH TENSION LEADS FOR GOOD CONDITION AND PROPERLY INSTALLED

1. ENGINE WILL NOT START

1. DISCONNECT CONNECTOR FROM DISTRIBUTOR CAP
2. CONNECT VOLTMETER BETWEEN CONNECTOR BATTERY TERMINAL AND GOOD GROUND
3. TURN IGNITION ON, ENGINE NOT TO BE CRANKED
4. OBSERVE METER READING

NOTE: IF READING IS ZERO AN OPEN CIRCUIT EXISTS IN ONE OF THE FOLLOWING

a. LEAD BETWEEN DISTRIBUTOR AND BULKHEAD CONNECTOR
b. LEAD BETWEEN BULKHEAD AND IGNITION SWITCH
c. RED LEAD BETWEEN IGNITION SWITCH AND STARTER SOLENOID

NOTE: IF READING IS SAME AS BATTERY VOLTAGE

a. REMOVE SPARK PLUG LEAD AT PLUG
b. HOLD LEAD WITH HIGH TENSION PLIERS 1/4" FROM GOOD GROUND
c. CRANK ENGINE OVER

NOTE: GOOD SPARK INDICATES BAD PLUG OR FUEL PROBLEM

NOTE: NO SPARK, CHECK IGNITION SYSTEM COMPONENTS

2. CHECK DISTRIBUTOR CAP AND ROTOR

1. REMOVE CAP AND COIL ASSEMBLY FROM HOUSING
2. REMOVE WIRING HARNESS CONNECTOR
3. REMOVE BATTERY LEAD
4. TURN CAP UPSIDE DOWN
5. MAKE SURE THERE ARE NO ARC-OVER SIGNS ON CAP OR ROTOR

6. EXAMINE SPARK PLUG TERMINALS
7. EXAMINE HIGH TENSION CARBON BUTTON
8. EXAMINE CONNECTOR TERMINALS

NOTE: ANY SIGN OF ARCING REPLACE FAULTY COMPONENT

3. TEST IGNITION COIL

1. CONNECT ONE OHMETER LEAD TO COIL BATTERY TERMINAL
2. OBSERVE METER

NOTE: METER READING NOT ZERO, REPLACE COIL

METER READING IS ZERO:

a. SET OHMMETER SELECTOR SCALE ON MIDDLE OR HIGH RANGE
b. CONNECT OHMMETER BETWEEN COIL TACH TERMINAL AND DISTRIBUTOR CAP CENTER HIGH TENSION CARBON BUTTON
c. OBSERVE METER READING

NOTE: INFINITE READING, REPLACE COIL. READING NOT INFINITE, CHECK PICK-UP COIL

4. TEST PICK-UP COIL

1. DISCONNECT (W&G) PICK-UP COIL LEADS TO MODULE
2. SET OHMMETER ON MIDDLE SCALE
3. CONNECT OHMMETER BETWEEN ONE PICK-UP COIL LEAD AND GOOD GROUND

NOTE: METER READING NOT INFINITE, REPLACE COIL

METER READING INFINITE:

a. CONNECT VACUUM TESTER TO VACUUM ADVANCE
b. OPERATE VACUUM TESTER MOVING PICK-UP COIL THROUGH ITS ENTIRE RANGE
c. OBSERVE METER READING

NOTE: METER READING DOES NOT REMAIN INFINITE AT ALL TIMES, REPLACE COIL. METER READING FOR BOTH PREVIOUS TESTS REMAIN INFINITE AT ALL TIMES:

a. CONNECT OHMMETER BETWEEN BOTH PICK-UP COIL LEADS
b. OPERATE VACUUM TESTER MOVING

PICK-UP COIL THROUGH ITS FULL RANGE

c. OBSERVE METER

NOTE: METER READING LESS THAN 650 OHMS OR MORE THAN 850 OHMS AT ANY TIME OR TEST, REPLACE PICK-UP COIL

NOTE: ALL PREVIOUS TESTS PROVE THAT PICK-UP COIL IS GOOD, REPLACE MODULE. IF MODULE DOES NOT CORRECT PROBLEM, REPLACE PICK-UP COIL. IF PERMANENT MAGNET LOSES MAGNETISM NO VOLTAGE WILL BE INDUCED IN PICK-UP COIL, MODULE WILL RECEIVE NO SIGNAL TO OPEN AND CLOSE IGNITION PRIMARY CIRCUIT, AND THE ENGINE WILL NOT START.

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT PRIMARY DIFFERENCE EXISTS IN THE GM HEI SYSTEM FROM OTHER ELECTRONIC SYSTEMS?

   THE DISTRIBUTOR HOUSES ALL ELECTRONIC IGNITION COMPONENTS.

2. WHAT TWO PARTS HAVE BEEN ELIMINATED FROM THE GM HEI SYSTEM OTHER THAN THE POINTS AND CONDENSER?

   THERE IS NO COIL TO DISTRIBUTOR HIGH TENSION LEAD; NEITHER IS THERE A PRIMARY RESISTANCE WIRE.

3. WHERE IS COIL HIGH TENSION VOLTAGE TEST MADE?

   AT THE CENTER CARBON BUTTON IN THE DISTRIBUTOR CAP

4. WHAT FURNISHES FULL BATTERY POWER TO THE IGNITION FOR ENGINE START?

   THE MODULE

5. WHAT PARTS MAKE UP THE MAGNETIC PICK-UP ASSEMBLY?

   PICK-UP COIL PLATE, PICK-UP COIL, PERMANENT MAGNET, AND POLE PLATE

6. WHAT ACTION SIGNALS THE ELECTRONIC MODULE TO TURN OFF THE CURRENT FROM THE BATTERY TO THE IGNITION COIL PRIMARY CIRCUIT?

TIMING CORE TEETH APPROACH AND ALIGN WITH POLE PIECE TEETH CAUSING A STRONG MAGNETIC FIELD. THIS MAGNETIC FIELD INDUCES AN ELECTRIC CURRENT. AS SOON AS THE TIMING CORE TEETH PASS THE POLE PIECE TEETH THE MAGNETIC FIELD STRENGTH DECREASES SUDDENLY. THIS SUDDEN DECREASE IN FIELD STRENGTH REVERSES THE CURRENT IN THE PICK-UP COIL. THIS REVERSAL OF CURRENT SIGNALS THE MODULE TO TURN OFF THE IGNITION COIL PRIMARY CIRCUIT BATTERY CURRENT.

7. HOW DO HEI SYSTEM PROBLEMS APPEAR IN AN AUTOMOTIVE ENGINE?

   AN ENGINE WILL NOT RUN OR IT WILL RUN ROUGH.

8. IF A PICK-UP COIL PASSES ALL OHMMETER TESTS, WHAT OTHER FAULT COULD EXIST THAT WOULD CAUSE AN ENGINE NOT TO START?

   IF THE PICK-UP COIL PERMANENT MAGNET LOSES ITS MAGNETISM NO VOLTAGE WILL BE INDUCED IN THE PICK-UP COIL AND THE MODULE WILL RECEIVE NO SIGNAL TO OPEN OR CLOSE THE IGNITION COIL PRIMARY CIRCUIT, AND THE ENGINE WILL NOT START.

9. IF A SPARK INTENSITY TEST FOR A HIGH TENSION SPARK PLUG LEAD PROVES SATISFACTORY BUT AN ENGINE STILL DOES NOT FUNCTION PROPERLY, WHERE DOES THE PROBABLE CAUSE OF TROUBLE LIE?

   IT CAN BE ONE OF TWO PLACES, EITHER SPARK PLUGS OR FUEL.

10. WHAT ADDITIONAL PREPARATIONS MUST BE MADE TO TEST AN HEI SYSTEM OFF THE VEHICLE WITH A DISTRIBUTOR TESTER?

    WHEN THE HEI SYSTEM IS CHECKED OFF THE VEHICLE WITH A DISTRIBUTOR TESTER, A DISTRIBUTOR PULSE AMPLIFIER, OHMMETER, AND A COIL TESTER MUST BE INCLUDED.

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## IV. EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

1. THE DISTRIBUTOR HOUSING HAS NOT BEEN CHANGED FROM THE TYPE USED FOR THE BREAKER POINT SYSTEM. T

2. IN THE HEI SYSTEM THE TIMING CORE HAS REPLACED THE DISTRIBUTOR ROTOR. F

3. ZERO VOLTAGE BETWEEN THE MAGNETIC PICK-UP UNIT AND THE TIMING CORE CAUSES THE MODULE TO SIGNAL THE IGNITION COIL FOR SECONDARY VOLTAGE TO FIRE THE SPARK PLUGS. F

4. THE DISTRIBUTOR CAP CENTER CARBON BUTTON AS IN THE PAST IS THE SOURCE TO THE DISTRIBUTOR FOR HIGH SECONDARY VOLTAGE. T

5. THE HEI SYSTEM CURRENT LIMITER IS A PART OF THE MAGNETIC PICK-UP ASSEMBLY. F

6. THE MAGNETIC PICK-UP ASSEMBLY IS MADE TO ROTATE IN THE DISTRIBUTOR BY A VACUUM ADVANCE. T

7. THE TIMER CORE ROTATES ABOUT THE DISTRIBUTOR SHAFT AS WELL AS ROTATING WITH IT. T

8. WHEN CHECKING THE IGNITION COIL BATTERY SIDE THE OHMMETER MUST READ AT LEAST 12 OR THE COIL IS REPLACED. F

9. MAGNETIC PICK-UP COIL TESTS ARE MADE AT THE TWO LEADS W&G OR CONNECTOR TO MODULE. T

10. THE PERMANENT MAGNET IN THE PICK-UP ASSEMBLY MAINTAINS ITS MAGNETISM FROM THE MAGNETIC SIGNALS CREATED BY THE MECHANICAL ACTION OF THE POLE SHOE AND TIMING CORE. F

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## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

I. SYSTEM DESCRIPTION
   A. ALL PARTS HOUSED IN DISTRIBUTOR
   B. NO COIL TO DISTRIBUTOR HIGH TENSION LEAD IS USED
   C. NO PRIMARY RESISTANCE WIRE IS USED
   D. MODULE FURNISHES FULL BATTERY POWER TO THE COIL FOR ENGINE START
   E. SPARK PLUG GAP .080"
   F. SYSTEM CREATES 50,000 VOLTS
   G. SPARK PLUG LEAD 8 MM IN DIAMETER, EXTRA 1 MM IS INSULATION TO HELP PREVENT VOLTAGE LOSS

II. COIL
   A. HOUSED IN DISTRIBUTOR CAP
   B. HAS THREE LEADS
      1. GROUND
      2. BATTERY
      3. TACH

III. TIMING CORE
   A. HAS EXTERNAL TEETH ACCORDING TO NUMBER OF ENGINE CYLINDERS
   B. ROTATES WITH DISTRIBUTOR SHAFT
   C. ALSO ROTATES ON DISTRIBUTOR SHAFT, MOVED BY WEIGHTS, CENTRIFUGAL ADVANCE

- D. WORKS WITH MAGNETIC PICK-UP ASSEMBLY TO SIGNAL MODULE

IV. MAGNETIC PICK-UP ASSEMBLY
- A. MADE UP OF
    1. PERMANENT MAGNET
    2. PICK-UP COIL PLATE
    3. PICK-UP COIL
    4. POLE PLATE WITH INTERNAL TEETH ACCORDING TO NUMBER OF ENGINE CYLINDERS
- B. ROTATED BY VACUUM ADVANCE
- C. MOUNTED OVER MAIN BEARING ON DISTRIBUTOR HOUSING

V. MODULE
- A. IN DISTRIBUTOR HOUSING
- B. HAS FIVE CIRCUITS
    1. SPARK TRIGGER
    2. SWITCHES
    3. CIRCUIT LIMITER
    4. DWELL CONTROL
    5. DISTRIBUTOR PICK-UP

VI. REPEAT THEORY OF HEI OPERATION AS IN TOPIC F OF PRESENTATION

VII. MOVE ON TO JOB AND TASKS AND PERMIT STUDENT PRACTICE TESTING PROCEDURES

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SUGGESTED READING FOR STUDENT:

THE NEXT LESSON IS: VIII-C-21(I), "FUEL TANK"

# INFORMATION SHEET
# ON
# IGNITION SYSTEM

SUBJECT: Electronic Ignition System (HEI)

## INTRODUCTORY INFORMATION:

The General Motors High Energy Ignition System differs from other ignition systems in that:

A. The coil is built into the distributor cap.
B. The coil to distributor high tension lead has been eliminated.
C. Spark plug high tension leads have been increased by 1mm in diameter from 7mm to 8mm. This additonal increase in diameter is insulation. This additional insulation is to prevent voltage loss as the lead must withstand about 35,000 volts.
D. There is no primary resistance wire. The module furnishes full battery power to the ignition coil.
E. Included in the distributor is a capacitor. This capacitor is not a part of the ignition system; it is a noise suppressor for the radio.

The system requires special plugs which have about an .080" air gap. But when servicing spark plugs refer to the manufacturer's specifications.

## GENERAL INFORMATION:

The electronic module is a solid-state unit that contains five complete circuits which trigger the spark, switches, limit current, angle of dwell, and distributor pickup. The angle of dwell varies with the engine speed.

The conventional distributor housing contains the electronic module, radio noise capacitor, and the magnetic pickup assembly.

The magnetic pick up assembly is made up of the pick up coil plate, a permanent magnet, pick up coil, and a pole plate. This assembly is mounted over the main bearing on the distributor housing. The pick up coil plate is made to rotate by the vacuum-control unit which provides vacuum advance.

A timer core with teeth according to the number of cylinders is made to rotate with the distributor shaft. Also, it rotates on the distributor shaft controlled by conventional advance weights; therefore, centrifugal advance is provided.

When timer core external teeth match up with the internal teeth of the pole plate, voltage is induced inside the pick up coil and a signal is sent to the module to open and close the primary circuit in the ignition coil. This happens each time the distributor shaft rotates according to the number of cylinders in the engine. The primary circuit decreases and a high voltage is induced in the coil secondary winding. The high voltage is directed through the rotor, distributor cap, high tension leads, and spark plugs causing fire to ignite the fuel.

Trouble in the HEI system will appear in two ways. An engine will not start or it runs rough. The HEI system can be checked on or off the vehicle. When the system is checked off the vehicle a distributor tester can be used, but to do this a distributor pulse amplifier, an ohmmeter, and a coil tester must be added on. Follow the equipment manufacturer's specifications when testing the system with this method.

The HEI system can be tested with an oscilloscope in much the same manner as the breaker point system. However, be sure to follow specifications.

To check the HEI system on the vehicle first check the wiring connector for tight and clean. Make sure all spark plug high tension leads are in good shape and properly installed.

If the engine will not start:
1. Disconnect the connector from the distributor cap.
2. Connect a voltmeter between the battery terminal in the connector and a good ground.
3. Turn the ignition switch to the "on" position.
   NOTE: Engine is not to be cranked over.
4. Observe the meter reading.
   NOTE: If the reading is zero there is an open circuit in one of the following.
   A. The lead between the distributor and the bulkhead connector.
   B. The lead between the bulkhead connector and the ignition switch.
   C. The red lead between the ignition switch and the starter solenoid.
   NOTE: If the meter reading is the same as the battery voltage:
   A. Remove a spark plug high tension lead at the spark plug.
   B. Hold the lead with high tension pliers about 1/4" from a good ground.
   C. Crank the engine over.
   NOTE: If there is a good spark the trouble is either spark plugs or fuel.
   NOTE: If there is no spark, ignition system components must be checked.

Check Distributor Cap and Rotor
1. Remove distributor cap and coil assembly from distributor housing.
2. Remove wiring harness connector.
3. Remove battery lead.
4. Turn cap upside down.
5. Examine spark plug terminals in cap.
6. Examine high tension carbon button.
7. Examine connector terminals.
8. Make sure that there are no arc-over signs on cap or rotor.
   NOTE: If there are signs of arcing replace faulty component.

## Test Coil

1. Connect one ohmmeter lead to battery terminal as indicated on the distributor cap.
2. Observe meter reading.

   NOTE: If meter reading is not zero replace the coil.

   NOTE: If the meter reading is zero:

   1. Turn ohmmeter selector scale to middle or high range.
   2. Connect ohmmeter between the tach terminal and the coil high tension output lead (center carbon button in distributor cap).
   3. Observe meter reading.

   NOTE: If the reading is infinite, replace the coil.

   NOTE: If the meter reading is not infinite, a check of the pick up coil is made.

## Pick Up Coil Test

1. Disconnect pick up coil leads, W and G, to module.
2. Set ohmmeter on middle scale.
3. Connect the ohmmeter between a good ground and one pick up coil lead.
4. Observe meter reading.

   NOTE: If the meter reading is not infinite replace the pick up coil.

   NOTE: If the meter reading is infinite:

   1. Connect vacuum tester to vacuum advance.
   2. Operate vacuum tester moving the pick up coil through its entire range.
   3. Observe meter reading.

   NOTE: If the meter reading does not remain infinite at all times replace the pick up coil.

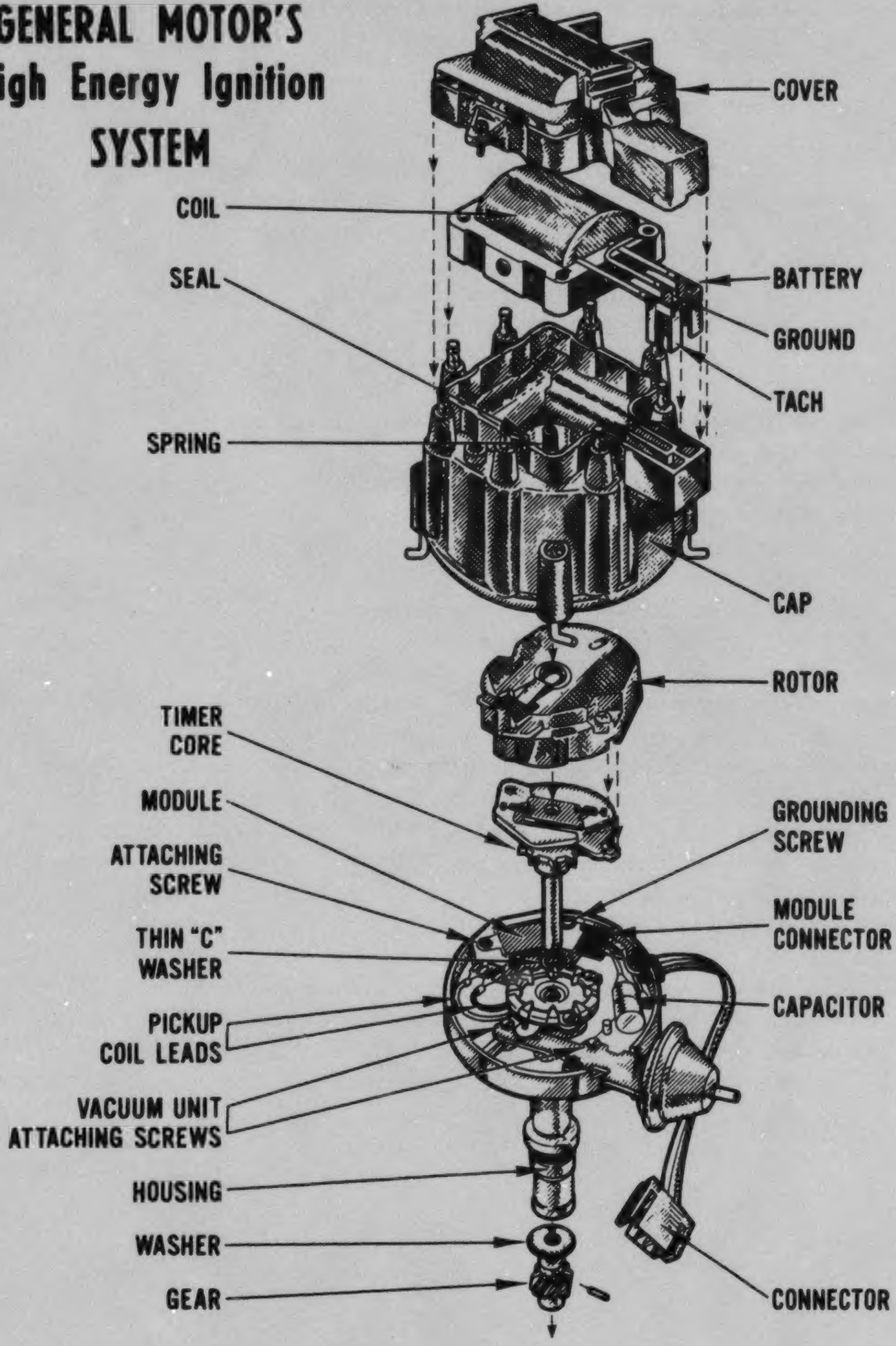
   NOTE: If the meter reading is infinite at all times for both previous tests:

   1. Connect ohmmeter between both pick up coil leads.
   2. Operate vacuum tester moving the pick up coil through its full range.
   3. Observe the ohmmeter.

   NOTE: If the meter reading is less than 650 ohms or more than 850 ohms at any time during the test, replace the pick up coil.

   NOTE: If the preceding pick up coil tests all prove to be negative replace the module. However, if the module does not correct the problem replace the pick up coil magnet. In case the magnet loses its magnetism no voltage will be induced in the pickup coil and, therefore, the module will receive no signal to open or close the primary circuit in the coil; so, the engine will not start.

# GENERAL MOTOR'S High Energy Ignition SYSTEM


COVER
COIL
SEAL
BATTERY
GROUND
TACH
SPRING
CAP
ROTOR
TIMER CORE
MODULE
GROUNDING SCREW
ATTACHING SCREW
MODULE CONNECTOR
THIN "C" WASHER
CAPACITOR
PICKUP COIL LEADS
VACUUM UNIT ATTACHING SCREWS
HOUSING
WASHER
GEAR
CONNECTOR

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-12(S)

| | |
|---|---|
| TASK: | TEST AND SERVICE ELECTRONIC, (H.E.I.), IGNITION SYSTEM (GENERAL MOTORS) |
| AIM: | THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF GENERAL MOTOR'S ELECTRONIC IGNITION SYSTEM, TO DETERMINE NEEDED ADJUSTMENTS, OR TO REPLACE SPECIFIC PARTS IN THE IGNITION SYSTEM: USING THE TOOLS AND TEST EQUIPMENT CALLED FOR IN THE TASK |
| TOOLS AND EQUIPMENT: | HAND TOOLS, VOLT-OHMMETER, TEST LEADS WITH PROBES, FENDER COVERS, SEAT COVERS, DROP LIGHT AND INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE (HEI TYPE), VACUUM TESTER |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | WIRING DIAGRAMS, MANUFACTURER'S REPAIR AND SERVICE MANUAL, EXPLODED VIEWS OF THE COMPONENTS |
| REFERENCES: | AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436<br>AUTOMECHANICS, PP. 289-294<br>MOTOR, OCTOBER, 1974, PP. 48, 49, 71, 91<br>GENERAL MOTORS SERVICE AND REPAIR MANUALS<br>VIII-C-10a(TS) JOB AND TASK SHEETS |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT MUST HAVE SATISFACTORILY COMPLETED PRECEDING TASKS IN MAJOR BLOCK VIII. STUDENTS MUST HAVE STUDIED JOB SHEET VIII-C-10(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON THE IGNITION SYSTEMS AND COMPONENTS |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. OBSERVE SAFETY RULES<br>3. PREPARATION AND HOOKUP OF THE TEST EQUIPMENT<br>4. THE USE OF TEST EQUIPMENT<br>5. TEST RESULTS ACCORDING TO SPECIFICATIONS<br>6. UNDERSTANDING THE NEED AND USE OF SPECIAL TOOLS AND EQUIPMENT<br>7. AN ATTITUDE OF APPRECIATION FOR CUSTOMER'S VEHICLE<br>8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN ABNORMAL OPERATION IS NOTED IN STARTING AND RUNNING OF A VEHICLE, IT IS NECESSARY TO MAKE CERTAIN CHECKS TO DETERMINE WHICH SYSTEM IS AT FAULT

DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF TESTS AND INSPECTIONS WHICH WILL POINT OUT COMPONENTS OF GENERAL MOTOR'S ELECTRONIC IGNITION SYSTEM (H.E.I.) THAT MAY BE AT FAULT IN CONTROLLING THE IGNITION SYSTEM. HOOKUP OF TEST EQUIPMENT TESTING PROCEDURES AND RECOMMENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED. SPECIAL CAUTIONS WILL BE GIVEN ON TEST HOOKUPS TO PREVENT DAMAGE TO THE IGNITION SYSTEM

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS |
| | 2. RAISE HOOD AND INSTALL FENDER COVERS |
| 2. PRELIMINARY CHECK | 1. CHECK WIRING CONNECTOR FOR SECURE AND PROPER ATTACHMENT TO SIDE OF DISTRIBUTOR CAP |
| | 2. CHECK SPARK PLUG LEADS FOR SECURE AND PROPER ATTACHMENT AT THE PLUGS |
| | 3. CHECK DISTRIBUTOR TERMINALS FOR CORROSION AND TIGHTNESS |
| 3. NO START CONDITION TEST | 1. REMOVE CONNECTOR FROM DISTRIBUTOR CAP |
| | 2. ATTACH VOLTMETER POSITIVE LEAD TO BATTERY TERMINAL IN CONNECTOR |
| | 3. ATTACH VOLTMETER NEGATIVE LEAD TO A GOOD GROUND |
| | 4. TURN IGNITION SWITCH TO RUN POSITION |
| | NOTE: DO NOT CRANK ENGINE. NOTE THE VOLTMETER READING. IF THE VOLTAGE IS ZERO, THERE IS AN OPEN CIRCUIT IN ONE OR MORE OF THESE AREAS |

   a. WIRE BETWEEN THE DISTRIBUTOR AND BULKHEAD CONNECTOR
   b. WIRE BETWEEN THE BULKHEAD CONNECTOR AND IGNITION SWITCH
   c. BETWEEN THE IGNITION SWITCH (IN THE 10 GAUGE RED WIRE) AND STARTER SOLENOID

5. TURN IGNITION SWITCH OFF

**4. COIL TEST**

1. REMOVE WIRING HARNESS CONNECTOR AND BATTERY LEAD
2. TURN FOUR CAP-TO-HOUSING LATCHES ON THE DISTRIBUTOR CAP ½ TURN COUNTERCLOCKWISE
3. LIFT OFF DISTRIBUTOR CAP AND COIL ASSEMBLY
4. TURN CAP AND COIL ASSEMBLY OVER SO THAT DISTRIBUTOR SPARK PLUG TERMINALS, THE COIL HIGH TENSION CARBON BUTTON, AND THE DISTRIBUTOR CONNECTOR TERMINAL ARE ALL FACING UP
5. CHECK FOR EVIDENCE OF SPARK ARC-OVER ON THE DISTRIBUTOR CAP AND ROTOR

   NOTE: IF EVIDENCE OF ARC-OVER IS FOUND, REPLACE FAULTY COMPONENT
6. ATTACH OHMMETER POSITIVE LEAD WIRE TO BATTERY TERMINAL AS INDEXED ON DISTRIBUTOR CAP

   NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL
7. ATTACH NEGATIVE LEAD TO A GOOD GROUND

   NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL
8. TURN OHMMETER SIDE SELECTOR TO MIDDLE OF HIGH RANGE
9. ATTACH ONE OHMMETER LEAD TO THE TACHOMETER TERMINAL AND OTHER LEAD TO COIL OUTPUT LEAD, WHICH IS CARBON BUTTON LOCATED AT THE CENTER OF THE DISTRIBUTOR CAP

NOTE: IF OHMMETER READS INFINITE REPLACE COIL

5. PICKUP COIL CHECK

1. DISCONNECT PICKUP COIL LEADS GOING TO MODULE MARKED W & G
2. SET OHMMETER FOR MIDDLE SCALE READING
3. ATTACH OHMMETER POSITIVE LEAD TO A PICK UP COIL LEAD
4. ATTACH OHMMETER NEGATIVE LEAD TO A GOOD GROUND

NOTE: IF OHMMETER READING IS NOT INFINITE, REPLACE THE PICKUP COIL (SHOULD BE INFINITE AT ALL TIMES)

5. CONNECT VACUUM ADVANCE TO A VACUUM TESTER
6. ACTIVATE VACUUM UNIT BY USING THE VACUUM TESTER

NOTE: OBSERVE THE OHMMETER THROUGHOUT THE ENTIRE VACUUM RANGE. IT SHOULD REMAIN INFINITE AT ALL TIMES. IF IT DOES NOT REPLACE PICKUP COIL

7. ATTACH OHMMETER LEAD WIRE TO ONE OF PICKUP COIL LEAD WIRES
8. ATTACH OTHER OHMMETER LEAD WIRE TO REMAINING LEAD WIRE OF PICKUP COIL

NOTE: IF THE READING IS LESS THAN 650 OR MORE THAN 850 OHMS AT ANY TIME WHILE THE VACUUM TESTER IS ACTIVATING THE ADVANCE UNIT, REPLACE PICKUP COIL. IF NO FAULT HAS BEEN FOUND AT THIS POINT, REPLACE THE MODULE AND IF THE CONDITION STILL EXISTS, CHECK PICKUP MAGNET

6. PICKUP COIL MAGNET TEST

1. KEY STILL OFF
2. TOUCH MAGNET POLE WITH TIN OR LIGHT STEEL FEELER GAUGE BLADE

NOTE: MAGNETISM SHOULD BE STRONG ENOUGH TO HOLD BLADE TIGHTLY IN PLACE. IF NOT, REPLACE MAGNET

3. DISCONNECT TEST EQUIPMENT

   CAUTION: CHECK GENERAL MOTOR'S HOOKUP RECOMMENDATIONS BEFORE ATTACHING ANY TEST INSTRUMENT FOR MEASURING ENGINE SPEED

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## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

ISSUE JOB SHEET VIII-C-12(J) GENERAL MOTORS. STUDENTS TO PRACTICE THE JOB AND TASKS INVOLVED IN TESTING AND SERVICING GENERAL MOTOR'S HIGH ENERGY IGNITION SYSTEM

SHOP ACTIVITIES TO BE UNDER CLOSE SUPERVISION OF INSTRUCTOR AND OF SUCH LENGTH THAT STUDENTS WILL BECOME FAMILIAR WITH AND SUCCESSFULLY PERFORM ALL TASKS

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## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

PERFORMANCE TEST - PLACE STUDENTS ON THEIR OWN, UNDER ACTUAL SHOP CONDITIONS, TO TEST AND SERVICE AN AUTOMOBILE'S ELECTRONIC IGNITION SYSTEM

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## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REVIEW TEST PROCEDURES FROM JOB VIII-C-12(J)
2. EMPHASIZE IMPORTANCE OF AVAILABLE BATTERY VOLTAGE
3. EMPHASIZE IMPORTANCE OF STEP BY STEP TEST PROCEDURE
4. EMPHASIZE IMPORTANCE OF LEARNING TO READ WIRING DIAGRAMS
5. EMPHASIZE IMPORTANCE OF IGNITION "OFF" AND "ON" POSITIONS
6. EMPHASIZE IMPORTANCE OF CLEAN AND TIGHT ELECTRICAL CONNECTIONS

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SUGGESTED READING FOR STUDENTS:

AUTOMOTIVE ENCYCLOPEDIA, PP. 431-436
AUTOMECHANICS, PP. 289-294
MOTOR, OCTOBER, 1974, PP. 48-49, 71, 91
GENERAL MOTORS SERVICE AND REPAIR MANUALS

THE NEXT LESSON IS: VIII-C-13(S) "TEST ENGINE VACUUM AND COMPRESSION"

JOB SHEET GENERAL MOTORS VIII-C-12(J)
IN
ELECTRONIC IGNITION SYSTEM

**JOB:** TEST ELECTRONIC IGNITION SYSTEM (H.E.I.)

**MATERIALS:** CLEAN RAGS

**TOOLS AND EQUIPMENT:** HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING, 1½ VOLT BATTERY POWERED, FERROUS FEELER GAUGE, DROP LIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE (HEI TYPE), VACUUM TESTER, TEST LEADS WITH PROBES, FENDER COVERS, SEAT COVER

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB, READ REFERENCE MATERIAL. STUDY JOB AND TASK SHEETS. BE SURE SEAT AND FENDERS ARE PROTECTED WITH SUITABLE COVERS BEFORE STARTING THE JOB. THE JOB IS TEST AND LOCATE ANY MALFUNCTION IN THE ELECTRONIC IGNITION SYSTEM THAT MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO ARRIVE AT TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE MAINTENANCE NEEDED TO CORRECT HEI SYSTEM PROBLEMS

**PROCEDURES AND/OR TASKS:**

1. GENERAL MOTORS, PRELIMINARY CHECK
2. GENERAL MOTORS, NO START TEST
3. GENERAL MOTORS, COIL TEST (IGN)
4. GENERAL MOTORS, PICK-UP COIL TEST
5. GENERAL MOTORS, PICK-UP COIL MAGNET TEST

**CHECK POINT:** CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

| | |
|---|---|
| VIII-C-1(J) | SERVICE STORAGE BATTERY |
| VIII-C-1(J) | TEST STORAGE BATTERY |
| VIII-C-1d(TS) | CLEAN WORK STATION |
| VIII-C-12(TS) | PRELIMINARY TEST |
| VIII-C-12a(TS) | NO START TEST |
| VIII-C-12b(TS) | COIL TEST |
| VIII-C-12c(TS) | TEST PICKUP COIL |
| VIII-C-12d(TS) | TEST PICKUP COIL MAGNETISM |

TASK SHEET GENERAL MOTORS VIII-C-12(TS)

| | |
|---|---|
| TASK: | PRELIMINARY TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM (H. E. I.) |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1½ VOLT BATTERY, TEST LEADS WITH PROBES, DROP LIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE, (HEI TYPE), VACUUM TESTER, FENDER COVERS, SEAT COVER, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | 1. AS PER VIII-C-1(J) STORAGE BATTERY TEST<br>2. CHECK WIRING CONNECTOR FOR SECURE AND PROPER ATTACHMENT TO SIDE OF DISTRIBUTOR CAP<br>3. CHECK SPARK PLUG LEADS FOR PROPER ATTACHMENT AT SPARK PLUGS<br>4. CHECK DISTRIBUTOR TERMINALS FOR CORROSION AND TIGHTNESS<br>NOTE: SPARK PLUG WIRE IS OF SPECIAL RESISTANCE TYPE CONSTRUCTION. USE CARE IN REMOVAL FROM PLUGS TO PREVENT PULLING OFF TERMINALS OR BREAKING CORE. CLEAN WITH CLOTH MOISTENED WITH KEROSENE OR OTHER CLEANING AGENTS. INSPECT FOR CUTS, WORN SPOTS, AND BREAKS IN INSULATION. INSPECT TERMINALS FOR CORROSION, BREAKS, OR DISTORTION |

TASK SHEET GENERAL MOTORS VIII-C-12a(TS)

| | |
|---|---|
| TASK: | NO START TEST |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM - H.E.I. |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1½ VOLT BATTERY, TEST LEADS WITH PROBES, DROP LIGHT, INSULATED PLIERS, TACH-DWELL METER, OSCILLOSCOPE- HEI TYPE, VACUUM TESTER, FENDER COVERS, SEAT COVERS, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-1(TS) GENERAL MOTORS |
| 4. NO START CONDITION TEST | 1. REMOVE CONNECTOR FROM DISTRIBUTOR CAP |
| | 2. ATTACH VOLTMETER POSITIVE LEAD TO BATTERY TERMINAL IN CONNECTOR |
| | 3. ATTACH VOLTMETER NEGATIVE LEAD TO GOOD GROUND |
| | 4. TURN IGNITION SWITCH TO "ON" POSITION<br>NOTE: DO NOT CRANK ENGINE OVER |
| | 5. NOTE VOLTMETER READING<br>NOTE: IF THE VOLTAGE IS ZERO, THERE IS AN OPEN CIRCUIT IN ONE OR MORE OF THESE AREAS:<br>a. 18 PINK WIRE BETWEEN BULKHEAD CONNECTOR AND DISTRIBUTOR<br>b. 12 PINK WIRE BETWEEN IGNITION SWITCH AND BULKHEAD CONNECTOR<br>c. 10 RED WIRE BETWEEN BULKHEAD CONNECTOR AND STARTER SOLENOID |
| | 6. TURN IGNITION SWITCH OFF<br>NOTE: IF READING IS BATTERY VOLTAGE AND SPARK OCCURS WHILE CRANK- |

| STEPS | KEY POINTS |
|---|---|
| | ING ENGINE AND MAKING SPARK CHECK AT SPARK PLUG LEAD, TROUBLE IS NOT IN DISTRIBUTOR |

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TASK SHEET GENERAL MOTORS VIII-C-12b(TS)

**TASK:** COIL TEST

**JOB:** TEST ELECTRONIC IGNITION SYSTEM - H. E. I.

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HAND TOOLS, OSCILLOSCOPE - H. E. I., TACH-DWELL METER, VOLTMETER, OHMMETER, 20,000 OHM/VOLT RATING POWERED BY 1½ VOLT BATTERY, DROP LIGHT, TEST LEADS WITH PROBES, VACUUM TESTER, FENDER COVER, SEAT COVERS, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-1(TS) |
| 4. COIL TEST | 1. REMOVE WIRING HARNESS CONNECTOR AND BATTERY LEAD<br>2. TURN 4 CAP-TO-HOUSING LATCHES ON DISTRIBUTOR CAP ¼ TURN COUNTERCLOCKWISE<br>3. LIFT OFF DISTRIBUTOR CAP CAN COIL ASSEMBLY<br>4. TURN CAP AND COIL ASSEMBLY OVER WITH DISTRIBUTOR SPARK PLUG TERMINAL, COIL HIGH-TENSION CARBON BUTTON, AND DISTRIBUTOR CONNECTOR TERMINAL ARE ALL FACING UP<br>5. CHECK FOR EVIDENCE OF SPARK ARC-OVER ON ROTOR CAP AND COIL<br>NOTE: IF EVIDENCE OF ARC-OVER IS FOUND, REPLACE FAULTY COMPONENT<br>6. ATTACH ONE OHMMETER LEAD TO BATTERY TERMINAL AS INDEXED ON DISTRIBUTOR CAP<br>7. ATTACH OTHER OHMMETER TEST LEAD TO GOOD GROUND<br>NOTE: READING SHOULD BE ZERO. IF NOT, REPLACE COIL |

| STEPS | KEY POINTS |
|---|---|
| | 8. TURN OHMMETER SCALE TO MIDDLE OR HIGH RANGE |
| | 9. ATTACH ONE OHMMETER LEAD TO TACHOMETER TERMINAL |
| | 10. ATTACH OTHER OHMMETER LEAD TO COIL OUPUT LEAD (CARBON BUTTON AT CENTER OF DISTRIBUTOR CAP) |
| | 11. OBSERVE OHMMETER READING<br>NOTE: IF OHMMETER READING IS INFINITE, REPLACE COIL |

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TASK SHEET GENERAL MOTORS VIII-C-12c(TS)

TASK: TEST PICKUP COIL

JOB: TEST ELECTRONIC IGNITION SYSTEM, H.E.I.

TOOLS AND MATERIALS: HAND TOOLS, OSCILLOSCOPE, HEI, TACH-DEWLL METER, VOLTMETER, OHMMETER 20,000 OHM/VOLT RATING POWERED BY 1½ VOLT BATTERY, DROP LIGHT, TEST LEADS WITH PROBES, VACUUM TESTER, FENDER COVERS, SEAT COVERS, CLEAN RAGS

TASK BREAKDOWN:

| | STEPS | | KEY POINTS |
|---|---|---|---|
| 1. | POSITION VEHICLE | | AS IN PREVIOUS TASKS |
| 2. | PREPARE VEHICLE | | AS IN PREVIOUS TASKS |
| 3. | PREPARE FOR TESTING | | AS PER VIII-C-10(TS) GENERAL MOTORS |
| 4. | PICKUP COIL TEST | 1. | DISCONNECT PICKUP COIL LEADS GOING TO THE MODULE MARKED W & G |
| | | 2. | SET OHMMETER FOR MIDDLE SCALE READING |
| | | 3. | ATTACH OHMMETER POSITIVE LEAD TO A PICKUP COIL LEAD |
| | | 4. | ATTACH OHMMETER NEGATIVE LEAD TO A GOOD GROUND |
| | | 5. | NOTE OHMMETER READING |
| | | | NOTE: OHMMETER SHOULD READ INFINITE AT ALL TIMES. IF READING IS NOT INFINITE REPLACE PICKUP COIL |
| | | 6. | CONNECT VACUUM TESTER TO VACUUM ADVANCE |
| | | 7. | ACTIVATE VACUUM UNIT WITH VACUUM TESTER |
| | | 8. | OBSERVE OHMMETER READING THROUGHOUT ENTIRE VACUUM RANGE |
| | | | NOTE: OHMMETER READING SHOULD BE INFINITE AT ALL TIMES. IF NOT, REPLACE PICKUP COIL |
| | | 9. | ATTACH ONE OHMMETER LEAD TO ONE WIRE OF PICKUP COIL |
| | | 10. | ATTACH OTHER OHMMETER LEAD TO REMAINING WIRE ON PICKUP COIL |

| STEPS | KEY POINTS |
|---|---|
| | 11. NOTE READING ON OHMMETER SCALE<br>NOTE: IF READING IS LESS THAN 650 OR MORE THAN 850 OHMS AT ANY TIME WHILE ACTIVATING VACUUM ADVANCE UNIT, REPLACE PICKUP COIL. IF NO FAULT HAS BEEN FOUND AT THIS POINT, REPLACE MODULE AND IF THE CONDITION STILL EXISTS, CHECK PICKUP COIL MAGNET |

TASK SHEET GENERAL MOTORS VIII-C-12d(TS)

| | |
|---|---|
| TASK: | TEST PICKUP COIL MAGNETISM |
| JOB: | TEST ELECTRONIC IGNITION SYSTEM H.E.I. |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | HAND TOOLS, DROP LIGHT, FENDER COVERS, SEAT COVERS, FERROUS FEELER GAUGE OR LIGHT STEEL STRIP OF METAL, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TESTING | AS PER VIII-C-10(TS) GENERAL MOTORS<br>VIII-C-10b(TS) GENERAL MOTORS |
| 4. TEST PICKUP COIL MAGNETISM | 1. TURN KEY OFF<br>2. CLEAN PICKUP COIL MAGNET WITH CLEAN RAG<br>3. TOUCH POLE OF MAGNET WITH METAL FEELER GAUGE BLADE<br>NOTE: MAGNETISM AT THIS POINT SHOULD BE STRONG ENOUGH TO HOLD BLADE TIGHTLY IN PLACE. IF NOT, REPLACE MAGNET<br>4. DISCONNECT ANY TEST EQUIPMENT<br>CAUTION: CHECK GENERAL MOTOR'S HOOKUP RECOMMENDATIONS BEFORE ATTACHING ANY TEST INSTRUMENT TO H.E.I. SYSTEM |

# INFORMATION SHEET
# ON
# ENGINE TROUBLE DIAGNOSIS

SUBJECT: Cylinder Compression and Manifold Vacuum Tests

## INTRODUCTORY INFORMATION:

As manufacturers continue to improve engine design, engines have decreased greatly in size, yet increased in power output. This calls for closer clearances, finer fits, and more accurate adjustments for the maintenance of satisfactory engine performance.

Fine adjustments necessary for peak running condition are obviously futile if the engine has major internal defects. Therefore one of the first checks made is to detect evidence of leaking piston rings, faulty valves or valve timing, leaking or loose bearings or worn camshaft lobes.

## GENERAL INFORMATION:

One of the first steps of engine tune-up is to make sure each cylinder has compression pressure within the range specified by the engine manufacturer. It is also important to note pressure variation between cylinders as this variance will have a more adverse effect upon engine performance than overall readings of slightly below specifications. Cylinders with readings within ten pounds of each other are not likely to be noticeable in the performance of the engine. If the pressure variation exceeds ten pounds above normal, the heads should be removed and the carbon scraped from all surfaces of the combustion chamber. The problem in this case being a reduction of volume in the combustion chamber resulting from carbon buildup.

Readings below normal indicate loss of compression past the valves, piston rings, or through a leaking gasket. If pressure is increased after placing a small amount of oil in cylinders having low readings, the problem is probably with worn piston rings. If readings remain steady and low, the problem is likely a loss of pressure past the valves. In either case, an abnormal loss of compression requires the removal of cylinder heads to make an accurate diagnosis.

Intake Manifold Vacuum. The vacuum gauge is another very important engine tester. In the hands of an experienced operator, it can provide considerable useful information about the condition of internal parts of the engine. Vacuum tests are made and the readings used in three different ways: as a preliminary test before any corrections are made, as a final test to prove the effectiveness of corrections, and to adjust the carburetor. When properly used and understood, the vacuum gauge will indicate the following defects:

Improper valve action
Restricted exhaust system

Cylinder leakage
Intake system leakage
Ignition timing
Ignition defects
Incorrect carburetor adjustment

The vacuum gauge is usually connected to the intake manifold at the windshield wiper connection. The needle indicator is then closely observed while the engine runs at idle speed. Normal vacuum reading is between 17 and 20. The following interpretations apply to most engines.

Normal and steady -- a fair indication that little of anything is wrong with engine operation at that particular speed and load condition.

Low and steady -- indicates a power reduction caused by late ignition or valve timing, or a loss of compression.

Very low -- intake manifold, carburetor spacer or head gasket leak.

Oscillations of the needle, increasing with engine speed -- partial or complete loss of power in one or more cylinders caused by a leaky head or manifold gasket, burnt valve, weak valve spring or a defect in the ignition system.

Gradual drop in reading at idle speed -- excessive back pressure in exhaust system, generally caused by clogged line.

Intermittent fluctuation -- defect in ignition system or sticking valve.

Slow fluctuation or drifting of the needle -- excessively rich air-fuel mixture or restricted crankcase ventilation system.

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-13(S)

**TASK:** TEST ENGINE VACUUM AND COMPRESSION

**AIM:**

1. THE STUDENT WILL BE ABLE TO VACUUM TEST THE ENGINE FOLLOWING THE PROPER PROCEDURES AND WILL ALSO BE ABLE TO DETERMINE THE EFFECTIVENESS OF THE VEHICLE'S VACUUM ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS.
2. THE STUDENT WILL BE ABLE TO TEST THE ENGINE'S COMPRESSION WITH THE PROPER EQUIPMENT AND DETERMINE THE EFFECTIVENESS OF THE RINGS AND VALVES.

**TOOLS AND EQUIPMENT:** VACUUM GAUGE, COMPRESSION GAUGES, SPARK PLUG, WRENCH, SENDING UNIT ADAPTER, SOCKET, SPEED HANDLE, TABLESPOON

**MATERIALS:** MOTOR OIL, CLEAN RAGS

**TEACHING AIDS:**

**REFERENCES:**
AUTOMOTIVE ENCYLOPEDIA, PP. 49-56, 173-186
AUTO SERVICE AND REPAIR, CH. 23
AUTOMOTIVE MECHANICS, CHS. 3 AND 4

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT MUST KNOW THE PRINCIPLES OF ENGINE OPERATION INCLUDING THE FOUR STROKE CYCLE, COMPRESSION RATIOS, AND CUBIC INCHES DISPLACEMENT.

THE STUDENT MUST ALSO KNOW WHAT A VACUUM GAUGE AND A COMPRESSION GAUGE ARE AND BE FAMILIAR WITH THEIR BASIC FUNDAMENTALS OF OPERATION.

**CHECKING STANDARDS:**

1. PROPER USE OF THE VACUUM GAUGE.
2. PROPER IDENTIFICATION AND DIAGNOSIS OF MECHANICAL DEFICIENCIES DUE TO LACK OF VACUUM.
3. PROPER USE OF THE COMPRESSION GAUGE.
4. PROPER IDENTIFICATION AND DIAGNOSIS OF MECHANICAL DEFICIENCIES DUE TO LACK OF COMPRESSION.

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

1. THE GAUGES IN THIS LESSON ARE MECHANICAL DEVICES DESIGNED TO MEASURE THE ENGINE'S EFFICIENCY.

2. THE REASON FOR TESTING THE ENGINE'S EFFICIENCY IN THIS MANNER IS THAT IT IS FIRST OF ALL A SIMPLE PROCEDURE, AND IT ALSO DISCLOSES ANY PROBLEMS THAT MAY BE PRESENT IN TIMING VACUUM ADVANCE OR IN RING AND VALVE WEAR AND CLEARANCE.

3. THE TEST WILL BE ON THE CORRECT WAY TO INSTALL THE VACUUM GAUGE AND THE COMPRESSION GAUGE AND THE CORRECT ANALYSIS OF THE INFORMATION OBTAINED. ALSO INCLUDED WILL BE THE CORRECT PROCEDURE TO FOLLOW AS TO SAFETY PRECAUTIONS AND SAFETY RULES.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. DEMONSTRATE | 1. PERFORM ALL TASKS |
| | 2. MAKE ALL KEY POINTS CLEAR AND PRECISE |
| | 3. EMPHASIZE SAFETY |
| 2. POSITION VEHICLE | 1. PLACE VEHICLE IN STALL |
| | 2. PROPERLY ALIGNED |
| | 3. SET FOOT OR HAND BRAKE |
| | 4. STOP ENGINE |
| | 5. OPEN HOOD |
| 3. WARM ENGINE | 1. SET HAND BRAKE |
| | 2. PLACE IN NEUTRAL OR PARK |
| | 3. START ENGINE |
| | 4. ENGINE IS TO BE WARMED TO OPERATING TEMPERATURE |
| | 5. TURN ENGINE OFF |
| | 6. CHECK OIL<br>a. OIL SHOULD BE PROPER GRADE<br>b. CLEAN |
| 4. REMOVE SPARK PLUGS | 1. REMOVE SPARK PLUG CABLES<br>a. HOLD CABLE AT BOOT<br>b. PULL CABLE AT BOOT |
| | 2. CLEAN AROUND PLUGS<br>a. USE A CLEAN RAG<br>b. WIPE DIRT AND GRIME FROM PLUG<br>c. DO NOT PERMIT DIRT TO ENTER CYLINDER |
| | 3. REMOVE ALL SPARK PLUGS<br>a. USE SPARK PLUG SOCKET AND RATCHET<br>b. BE CAREFUL NOT TO BREAK PLUGS<br>c. LABEL PLUG AS TO CYLINDER REMOVED FROM TO INDICATE PROBLEM CYLINDER |

| | |
|---|---|
| 5. OPEN CHOKE AND THROTTLE VALVES | 1. REMOVE RETURN SPRING<br>a. DISCONNECT THROTTLE LINKAGE<br>b. DISCONNECT AUTOMATIC CHOKE<br>NOTE: BOTH VALVES MUST BE WIDE OPEN<br>2. BLOCK OPEN IF NECESSARY |
| 6. USE A REMOTE STARTER SWITCH | 1. INSTALL STARTER SWITCH<br>a. ATTACH ONE LEAD TO STORAGE BATTERY POSITIVE TERMINAL<br>b. ATTACH ONE LEAD TO STARTER SOLENOID<br>c. STAND TO SIDE OF FENDER<br>d. WEAR SAFETY GOGGLES |
| 7. USE COMPRESSION GAUGE | 1. PLACE COMPRESSION GAUGE IN NUMBER ONE CYLINDER<br>a. HOLD IN CYLINDER FIRMLY<br>b. MUST HAVE A GOOD SEAL AROUND RUBBER FITTING<br>c. HOLD WITH ENOUGH PRESSURE TO PREVENT BLOW-BY<br>2. TURN ENGINE OVER AT LEAST FOUR TIMES<br>a. USE STARTER SWITCH<br>b. WATCH COMPRESSION GAUGE<br>3. RECORD THE HIGHEST READING OBTAINED<br>4. PROCEED TO THE FOLLOWING CYLINDERS<br>a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS<br>b. WRITE DOWN HIGHEST COMPRESSION INDICATIONS FOR EACH RESPECTIVE CYLINDER<br>5. COMPRESSION IS TO BE BETWEEN 130 AND 170 PSI. AND A MAXIMUM VARIATION BETWEEN CYLINDERS OF 20 PSI. |
| 8. COMPARE COMPRESSION SCORE | 1. USE COMPRESSION PRESSURE LIMIT CHART FOR TYPICAL VEHICLE TESTING<br>2. ACCORDING TO TESTS AND CHART READINGS DECIDE IF THE ENGINE CAN BE CORRECT BY TUNE-UP<br>a. VARIANCES OF MORE THAN PRE- |

SCRIBED RANGE INDICATE THAT THE CYLINDERS, RINGS, OR VALVES - OR ALL THREE - ARE DEFECTIVE

b. USE OIL TEST

9. OIL CYLINDERS

1. TEST FOR RING AND VALVE SEATING
   a. PUT ONE TABLESPOON OF OIL IN EACH CYLINDER
   b. INSERT COMPRESSION GAUGE
2. TURN ENGINE AT LEAST FOUR TIMES
   a. THE SAME PRESSURE AS BEFORE MEANS VALVES ARE BURNT AND ARE NOT SEATING
   b. INCREASE IN PRESSURE MEANS THE OIL HAS HELPED THE RINGS TO SEAL AND THE RINGS ARE WORN PAST EFFECTIVENESS, THE CYLINDER IS CONE SHAPED, OR BROKEN PISTON
3. PROCEED TO THE FOLLOWING CYLINDERS
   a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS
   b. WRITE DOWN HIGHEST COMPRESSION INDICATION FOR EACH RESPECTIVE CYLINDER
   c. TWO WEAK CYLINDERS ADJACENT MIGHT INDICATE A "BLOWN" CYLINDER HEAD GASKET
4. REPLACE SPARK PLUGS
   a. USE SPARK PLUG WRENCH
   b. BE CAREFUL NOT TO CROSS THE THREADS

USE A VACUUM GAUGE

1. WARM THE ENGINE

1. ENGINE TO BE WARMED TO OPERATING TEMPERATURE
2. RUN ENGINE AT SLIGHTLY HIGHER THAN IDLING SPEED
3. TURN ENGINE OFF

2. ATTACH VACUUM GAUGE

1. ATTACH TO THE INTAKE MANIFOLD
   a. ATTACH TO THE INLET PIPE ON THE INTAKE MANIFOLD - USE AN ADAPTER
   b. AVOID LEAKS IN THE WINDSHIELD

WIPER OR CONNECTIONS

2. ATTACH TO ANY VACUUM HOSE IF NECESSARY

3. MAKE CRANKING TEST

1. BACK OFF THE IDLE SPEED SCREW TO ALLOW THE THROTTLE VALVE TO FULLY CLOSE
2. GROUND THE COIL HIGH TENSION WIRE
3. CRANK ENGINE AND AVERAGE READINGS
    - a. RELATIVELY STEADY, HIGH VACUUM INDICATES AN ABSENCE OF VACUUM LEAKS AND GOOD RING AND VALVE ACTION
    - b. LOW, BUT FAIRLY STEADY READING CAN MEAN VACUUM LEAKS, WORN VALVE GUIDES, POOR COMPRESSION, VALVE TIMING OFF
    - c. AN ERRATIC READING CAN POINT TO BURNED OR STICKY VALVES, DAMAGED PISTON, BLOWN GASKET
4. READJUST IDLE SCREW
    - a. USE APPROPRIATE TOOL
    - b. FOLLOW MANUFACTURER'S SPECIFICATIONS FOR IDLE SPEED
5. REATTACH COIL SECONDARY WIRE TO DISTRIBUTION

4. MAKE VACUUM TEST-ENGINE RUNNING

1. CORRECT RESPONSE:
    - a. NEEDLE WILL BE STEADY AT BETWEEN 17-21 WHEN IDLING
    - b. SUDDENLY OPEN AND CLOSE THE THROTTLE
    - c. NEEDLE WILL DROP TO BELOW 5, THEN BOUNCE UP TO AROUND 25

NOTE: SUBTRACT ONE INCH FROM THE SPECIFIED READING FOR EVERY 1,000 FEET OF ELEVATION ABOVE SEA LEVEL.

2. LEAKING RINGS:
    - a. FAIRLY STEADY NEEDLE
    - b. 3-4 POINTS LOWER THAN NORMAL
    - c. SUDDEN OPEN AND CLOSING OF THROTTLE NEEDLE MAY SINK TO ZERO THEN BOUNCE TO ABOUT 22

3. SLOW TIMING:
   a. GOOD COMPRESSION
   b. LOW NEEDLE READING
   c. A CONSIDERABLE LOW NEEDLE READING MEANS THE VALVE TIMING MAY BE SLOW
   d. CARBURETOR ADJUSTMENT WILL NOT CHANGE VACUUM TO NORMAL --MAKE A CHECK TO SEE IF EITHER OR BOTH IGNITION OR VALVE TIMING SHOULD BE ADVANCED (VIII-C-13(IS))
4. LEAKING INTAKE:
   a. STEADY NEEDLE
   b. 3-9 POINTS LOW
   c. THROTTLE VALVE IS NOT CLOSING
   d. AIR LEAK EXISTS IN CARBURETOR OR INTAKE MANIFOLD OR GASKETS
5. LEAKING CYLINDER HEAD GASKET:
   a. FLOATING NEEDLE BETWEEN LOW AND HIGH READING
   b. CYLINDER HEAD GASKET BLOWN BETWEEN TWO ADJACENT CYLINDERS
6. CARBURETOR OUT OF ADJUSTMENT:
   a. NEEDLE FLOATS SLOWLY
   b. RANGE OF 4-5 POINTS
7. SPARK PLUG CAPS:
   a. NEEDLE FLOATS SLOWLY OVER A NARROWER RANGE - 2 POINTS
   b. SPARK PLUG GAP PROBABLY TOO CLOSE
   c. IGNITION POINTS MAY NOT BE OPERATING PROPERLY
8. RESTRICTED EXHAUST
   a. NEEDLE READS NORMAL RANGE UPON STARTING
   b. SINKS TO ZERO
   c. THEN RISES SLOWLY TO BELOW NORMAL
   d. CLOGGED PIPE
9. DEFECTIVE VALVE ACTION
   a. LEAKING, BURNED, STICKING VALVES, WEAK VALVE SPRINGS, OR WORN GUIDES

| | |
|---|---|
| | b. ACTION OF THE NEEDLE AND RANGE OF THE MOTION ARE INDICATORS OF FAULT<br>10. ENGINE MECHANICAL CONDITION<br>a. INDICATION OF LOSS OF COMPRESSION OR IMPROPER VALVE ACTION, TUNE-UP WILL DO NO GOOD, THESE MECHANICAL FAULTS MUST BE CORRECTED<br>b. INDICATION OF TIMING ERRORS, INTAKE LEAKS, CARBURETOR OUT OF ADJUSTMENT, OR RESTRICTED EXHAUST SYSTEM, CORRECT THESE DEFECTS AS THE NEXT STEP |
| 5. REMOVE VACUUM GAUGE | 1. REMOVE VACUUM GAUGE FROM INTAKE MANIFOLD<br>2. BE SURE TO REPLACE ANY VACUUM HOSES |
| 6. CHECK ENGINE OPERATION | 1. LISTEN FOR<br>a. ROUGH IDLE<br>b. ENGINE HOISES<br>c. VIBRATION<br>2. STOP ENGINE<br>3. REMOVE OIL PRESSURE GAUGE<br>4. REPLACE SENDING UNIT |
| 7. CLEAN WORK STATION | 1. MAKE FINAL INSPECTION UNDER HOOD<br>2. CLOSE HOOD<br>3. REMOVE CAR TO SAFE PLACE<br>4. APPLY SORB-ALL TO OILY SPOTS<br>5. WIPE VEHICLE CLEAN OF FINGER PRINTS<br>6. BRUSH OFF WORK BENCHES<br>7. SWEEP FLOOR<br>8. COUNT TOOLS<br>9. CHECK IN TOOLS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS PRACTICE ON THEIR OWN USING JOB AND TASK SHEETS VIII-C-13(J) UNDER SUPERVISION OF THE INSTRUCTOR.

2. OBSERVE AND RETEACH, IF THE NEED ARISES, THE USE OF THE COMPRESSION AND VACUUM GAUGE.

## III. APPLICATION (CON'T)

3. CHECK STUDENTS FOR KEY POINTS.
4. STUDENTS TO PRACTICE ON TASK.
5. HAVE STUDENTS DO MANIPULATIVE TASK AND GIVE KEY POINTS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

1. REPEAT EACH STEP FROM STAGE II.
2. REEMPHASIZE THE KEY POINTS IN STAGE II.
3. REPEAT THE DIFFERENT MALFUNCTIONS DETECTABLE BY THE COMPRESSION GAUGE AND VACUUM GAUGE.

SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, CH. 1
AUTOMOTIVE ENCYCLOPEDIA, PP. 7-23
AUTO SERVICE AND REPAIR, CHS. 1, 2, 3
AUTOMOTIVE MECHANICS, CH. 2

THE NEXT LESSON IS: VIII-C-14(S) "TEST D.C. TYPE CHARGING SYSTEM"

VIII-C-13(J)

# JOB SHEET
# IN
# ENGINE OPERATION AND DESIGN

| | | |
|---|---|---|
| JOB: | TEST ENGINE VACUUM AND COMPRESSION | |
| MATERIALS: | CLEAN RAGS, ENGINE OIL | |
| TOOLS AND EQUIPMENT: | OPEN END WRENCH, VACUUM GAUGE, COMPRESSION GAUGE, SPARK PLUG WRENCH, TABLESPOON | |
| GENERAL INSTRUCTIONS: | BEFORE DOING THIS JOB IT WILL BE ADVISABLE TO DO THE NECESSARY READING IN THE REFERENCES RELATED TO THIS JOB. ALSO, STUDY PREVIOUS INFORMATION SHEETS ON USING THE OIL PRESSURE GAUGE. | |
| PROCEDURE AND/OR TASKS: | VIII-C-1(TS) | PREPARE VEHICLE (EXCEPT DISCONNECT BATTERY) |
| | VIII-C-13(TS) | USE COMPRESSION GAUGE |
| | VIII-C-13a(TS) | USE VACUUM GAUGE |
| CHECK POINT: | BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK. | |

## TASK SHEET VIII-C-13(TS)

TASK: USE COMPRESSION GAUGE

JOB: TEST ENGINE VACUUM AND COMPRESSION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: COMPRESSION GAUGE, MOTOR OIL, CLEAN RAGS, SPARK PLUG WRENCH

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE SPARK PLUGS | 1. REMOVE SPARK PLUG CABLES<br>a. HOLD CABLE ON BOOT<br>b. PULL CABLE ON BOOT<br>CAUTION: PULLING ON CABLE WILL SEPARATE THE WIRE IN THE CABLE<br>2. MARK SPARK PLUG WIRES AS THEY ARE REMOVED<br>a. USE MASKING TAPE<br>b. INDICATE CYLINDER NUMBER AS IT IS REMOVED<br>3. CLEAN AROUND PLUGS<br>a. USE A CLEAN RAG<br>b. WIPE DIRT AND GRIME FROM PLUG<br>c. DO NOT PERMIT DIRT TO ENTER CYLINDER<br>4. USE RUBBER LINED SPARK PLUG SOCKET AND RATCHET<br>5. TURN TO THE LEFT ONE TURN<br>CAUTION: BE CAREFUL NOT TO SLIP AND BREAK THE PLUG INSULATOR<br>6. MARK EACH PLUG AS TO CYLINDER<br>NOTE: PLUG DAMAGE CAN BE RELATED TO CYLINDER CONDITION |
| 2. OPEN CHOKE AND THROTTLE VALVES OF CARBURETOR | 1. REMOVE THE AIR CLEANER<br>a. REMOVE WING NUT<br>b. DISCONNECT EMISSION CONTROL<br>2. OPEN VALVES WIDE OPEN<br>a. REMOVE RETURN SPRING FROM ACCELERATOR LINKAGE<br>3. PULL MANUAL CHOKE WIDE OPEN |

| STEPS | KEY POINTS |
|---|---|
| | 4. UNHOOK LINKAGE TO THE AUTOMATIC CHOKE AND PLACE WIDE OPEN |
| 3. USE REMOTE STARTER SWITCH | 1. GROUND DISTRIBUTOR END OF COIL SECONDARY WIRE<br>2. INSTALL STARTER SWITCH<br>a. ATTACH ONE LEAD TO THE STORAGE BATTERY POSITIVE CABLE<br>b. ATTACH ONE LEAD TO STARTER SOLENOID<br>c. BE SURE THE CLAMPS ARE ATTACHED TO RESPECTIVE PLACES SECURELY<br>3. LAY STARTER SWITCH ASIDE ON A FLAT SURFACE ACCESSIBLE TO EASY REACH<br>4. WEAR SAFETY GOGGLES |
| 4. USE COMPRESSION GAUGE | 1. INSERT COMPRESSION GAUGE TIGHTLY IN NUMBER 1 CYLINDER<br>a. INSERT GAUGE FITTING IN SPARK PLUG HOLE<br>b. USE ADAPTER IF NECESSARY<br>2. CRANK ENGINE<br>a. TURN ENGINE AT LEAST 4 TIMES<br>b. WATCH GAUGE<br>c. RECORD THE HIGHEST READING<br>3. RELEASE GAUGE NEEDLE<br>4. PROCEED TO OTHER CYLINDERS AND CONTINUE COMPRESSION TEST<br>a. FOLLOW PROCEDURE FOR EACH OF THE REMAINING CYLINDERS<br>b. RECORD HIGHEST READING FOR EACH OF THE RESPECTIVE CYLINDERS<br>5. COMPRESSION IS TO BE BETWEEN 130-170 PSI. AND A MAXIMUM VARIATION OF 20 PSI. |
| 5. INTERPRETING COMPRESSION READINGS | 1. LOW FIRST STROKE READING WITH LOW FINAL READING<br>a. WARPED VALVES<br>b. BURNED VALVES<br>c. STICKY VALVES<br>2. LOW FIRST STROKE WITH MODERATE FINAL READING |

| STEPS | KEY POINTS |
|---|---|
| | a. WORN RINGS<br>b. STUCK RINGS<br>c. SCORED RINGS<br>3. TWO ADJACENT CYLINDERS ARE LOW<br>a. BLOWN HEAD GASKET<br>b. WARPED HEAD TO BLOCK |
| 6. COMPARE COMPRESSION SCORES | 1. USE COMPRESSION PRESSURE LIMIT FOR TYPICAL VEHICLE TESTING<br>2. ACCORDING TO TEST AND CHART READING DECIDE IF THE ENGINE CAN BE CORRECTED BY A TUNE-UP<br>a. VARIANCES OF MORE THAN PRESCRIBED RANGE INDICATE THAT THE CYLINDERS, RINGS, AND VALVES--OR ALL THREE — ARE DEFECTIVE<br>b. USE OIL TEST |
| 7. OIL CYLINDERS | 1. RETEST CYLINDERS WITH LOW COMPRESSION<br>a. ADD 1 TABLESPOON OF 30 W. MOTOR OIL<br>b. INSERT COMPRESSION GAUGE<br>c. TURN ENGINE OVER AT LEAST 4 TIMES<br>d. CONSIDERABLE INCREASE IN COMPRESSION MEANS WORN RINGS<br>e. NO SIGNIFICANT INCREASE IN COMPRESSION INDICATES VALVE TROUBLE, BROKEN PISTON, OR BLOWN GASKET<br>2. HIGHER THAN NORMAL COMPRESSION<br>a. ENGINE HAS BEEN MODIFIED TO INCREASE COMPRESSION<br>b. BUILD UP OR CARBON ON THE HEAD OF A PISTON<br>CAUTION: IF CARBON BUILD-UP IS CAUSING PINGING THAT CANNOT BE STOPPED BY RETARDING THE TIMING, OR BY SWITCHING TO A HIGHER OCTANE GASOLINE, THE CARBON SHOULD BE REMOVED |

| STEPS | KEY POINTS |
|---|---|
| 8. REATTACH THE THROTTLE AND CHECK MECHANISM | 1. CONNECT THROTTLE MECHANISM<br>a. PLACE LINKAGE IN CORRECT POSITION AND RECLASP<br>b. REATTACH SPRING<br>2. CLOSE MANUAL CHOKE<br>3. REATTACH AUTOMATIC CHOKE<br>4. VISUALLY INSPECT FOR THE CORRECT HOOK-UP<br>5. TEST THROTTLE MANUALLY |

## TASK SHEET

VIII-C-13a(TS)

**TASK:** USE VACUUM GAUGE

**JOB:** TEST ENGINE VACUUM AND COMPRESSION

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** VACUUM GAUGE, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. WARM THE ENGINE | 1. ENGINE TO BE WARMED TO OPERATING TEMPERATURE<br>a. SET FOOT OR HAND BRAKE<br>b. PLACE VEHICLE IN PARK OR NEUTRAL<br>c. TURN ON IGNITION<br>d. WATCH TEMPERATURE GAUGE<br>2. RUN ENGINE AT SLIGHTLY HIGHER THAN IDLING SPEED FOR TEST<br>3. TURN ENGINE OFF |
| 2. ATTACH VACUUM GAUGE | 1. ATTACH TO THE INTAKE MANIFOLD<br>2. ATTACH ADAPTER TO AN AVAILABLE PLACE ON THE MANIFOLD (IF AVAILABLE)<br>a. CAN ATTACH TO VACUUM WINDSHIELD WIPERS<br>b. IF WIPERS ARE ELECTRIC, ATTACH TO SOME OTHER VACUUM OPERATED UNIT FITTING |
| 3. MAKE CRANKING TEST | 1. BACK OFF THE IDLE SPEED SCREW TO ALLOW THE THROTTLE VALVE TO FULLY CLOSE<br>2. GROUND THE COIL HIGH TENSION WIRE<br>3. CRANK ENGINE AND AVERAGE READINGS<br>a. RELATIVELY STEADY, HIGH VACUUM INDICATES AN ABSENCE OF VACUUM LEAKS AND GOOD RING AND VALVE ACTION<br>b. LOW BUT FAIRLY STEADY READING CAN MEAN VACUUM LEAKS, WORN VALVE GUIDES, POOR COMPRESSION, VALVE TIMING OFF |

| STEPS | KEY POINTS |
|---|---|
| | c. AN ERRATIC READING CAN POINT TO BURNED OR STICKY VALVES, DAMAGED PISTON, BLOWN GASKET<br>4. READJUST IDLE SCREW<br>a. USE APPROPRIATE TOOL<br>b. FOLLOW MANUFACTURER'S SPECIFICATION FOR IDLE SPEED<br>5. REATTACH COIL SECONDARY WIRES TO DISTRIBUTION |
| 4. VACUUM TEST - ENGINE RUNNING | 1. BRING ENGINE TO NORMAL OPERATING TEMPERATURE<br>2. RUN ENGINE AT SLIGHTLY HIGHER THAN NORMAL IDLING SPEED<br>3. NORMAL READING<br>a. NEEDLE WILL BE STEADY AT BETWEEN 17-21 WHEN IDLING<br>b. SUDDENLY OPEN AND CLOSE THE THROTTLE<br>c. NEEDLE WILL DROP TO BELOW 5 THEN BOUNCE UP TO AROUND 25<br>NOTE: SUBTRACT ONE INCH FROM THE SPECIFIED READING FOR EVERY 1,000 FEET OF ELEVATION ABOVE SEA LEVEL<br>4. LEAKING RINGS<br>a. FAIRLY STEADY NEEDLE<br>b. 3-4 POINTS LOWER THAN NORMAL<br>c. SUDDEN OPEN AND CLOSING OF THROTTLE NEEDLE MAY SINK TO ZERO THEN BOUNCE TO ABOUT 22<br>5. SLOW TIMING<br>a. GOOD COMPRESSION<br>b. LOW NEEDLE READING<br>c. A CONSIDERABLE LOW NEEDLE READING MEANS THE VALVE TIMING MAY BE SLOW<br>d. CARBURETOR ADJUSTMENT WILL NOT INCREASE THE VACUUM TO NORMAL - MAKE A CHECK TO SEE IF EITHER OR BOTH, IGNITION OR VALVE TIMING SHOULD BE ADVANCED (VIII-C-13(TS))<br>6. LEAKING INTAKE<br>a. STEADY NEEDLE |

| STEPS | KEY POINTS |
|---|---|

- b. 3-9 POINTS LOW
- c. THROTTLE VALVE IS NOT CLOSING
- d. AIR LEAK EXIST IN CARBURETOR OR INTAKE MANIFOLD OR GASKETS

7. LEAKING CYLINDER HEAD GASKET
   - a. FLOATING NEEDLE BETWEEN LOW AND HIGH READING
   - b. CYLINDER HEAD GASKET BLOWN BETWEEN TWO ADJACENT CYLINDERS
8. CARBURETOR OUT OF ADJUSTMENT
   - a. NEEDLE FLOATS SLOWLY
   - b. RANGE OF 4-5 POINTS
9. SPARK PLUG GAPS
   - a. NEEDLE FLOATS SLOWLY OVER A NARROWER RANGE OF ABOUT 2 POINTS
   - b. SPARK PLUG GAP PROBABLY TOO CLOSE
   - c. IGNITION POINTS MAY NOT BE OPERATING PROPERLY
10. RESTRICTED EXHAUST
    - a. NEEDLE READS NORMAL RANGE UPON STARTING
    - b. SINKS TO ZERO
    - c. THEN RISES SLOWLY TO BELOW NORMAL
    - d. CHECK FOR CLOGGED TAILPIPE
11. DEFECTIVE VALVE ACTION
    - a. LEAKING, BURNED, STICKING VALVES, WEAK VALVE SPRINGS, WORN GUIDES
    - b. ACTION OF NEEDLE AND RANGE OF THE MOTION ARE INDICATION OF A FAULT
12. ENGINE MECHANICAL CONDITION
    - a. INDICATION OF LOSS OF COMPRESSION OR IMPORPER VALVE ACTION, TUNE-UP WILL DO NO GOOD, THESE MECHANICAL FAULTS MUST BE CORRECTED
    - b. INDICATION OF TIMING ERRORS, INTAKE LEAKS CARBURETOR OUT OF ADJUSTMENT, OR A RESTIRCTED

| STEPS | KEY POINTS |
|---|---|
| | EXHAUST SYSTEM, CORRECT THESE DEFECTS AS THE NEXT STEP |
| 5. REMOVE VACUUM GAUGE | 1. REMOVE VACUUM GAUGE FROM INTAKE MANIFOLD OR ADAPTING POINT<br>2. BE SURE TO REPLACE AUTOMOTIVE EQUIPMENT VACUUM HOSES<br>3. PRESS VACUUM HOSES COMPLETELY UPON THE FITTING AS DESIGNED |

VIII-C-8(IS)

# INFORMATION SHEET
# ON
# AUTOMOTIVE CHARGING SYSTEMS

SUBJECT: Drive Belts

## INTRODUCTORY INFORMATION:

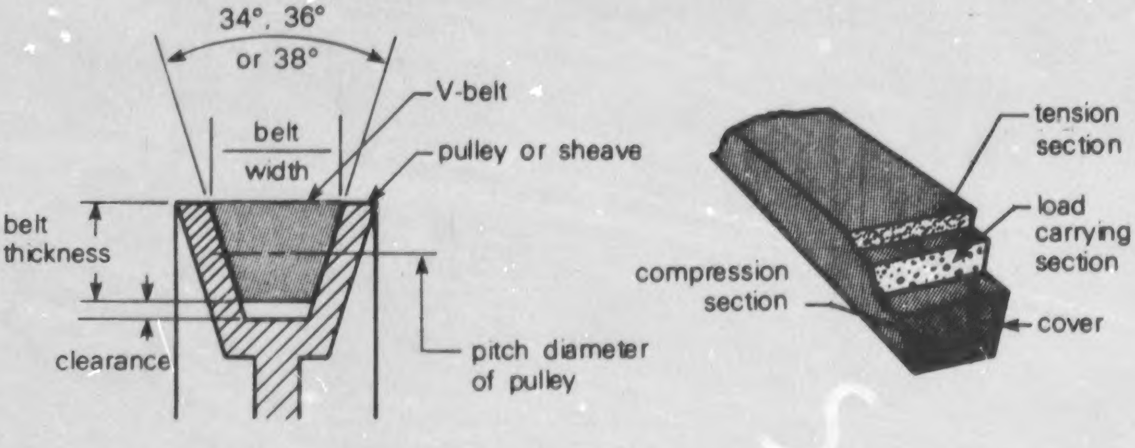
Most automobiles depend upon drive belts to carry power from the engine to the auxiliary power plants on the car such as the charging system, power steering, and air conditioning. Belts are used where positive speed synchronism is not imperative, in that belt drives operate with less noise than chain drives and require no lubrication.

A belt drive consists of an endless flexible belt that connects two wheels or pulleys. Belt drives depend upon friction between the belt and the pulleys for the transmission of power.

There are many types of belt drives, belts, and belting material, but the one which concerns the automobile is the V-belt.

## GENERAL INFORMATION:

The V-belt has a trapezoidal cross-section which runs in V-shaped grooves on the pulleys. These belts are constructed of cords and cables, impregnated with a rubber and organic compound, and covered to produce the required cross-section.


34°, 36°
or 38°
V-belt
belt
width
pulley or sheave
belt
thickness
clearance
pitch diameter
of pulley
tension
section
load
carrying
section
compression
section
cover

Although open end type belting can be purchased, V-belts are manufactured as endless belts and come in a large variety of sizes (cross-sections) and lengths.

Belt manufacturers have developed standards for the various types of V-belts, and these have been issued as A. S. A. (American Standards Association) for use throughout industry. The three major areas of application are industrial, automotive, and agricultural. Included in these standards are the service conditions as well as belt and sheave dimensions and formulas for figuring center distances. Automobile manufacturers have adopted these standards although their designation (part number) may vary according to each car manufacturer's standard parts list. Dealers and parts houses have cross-index catalogs which give the corresponding belt for each make, model, and engine type and size of most automobiles in service. When ordering replacement belts, these items should be given, plus whether vehicle is air-conditioned. Example: '71 Ford pick-up; 360 HP, automatic w/air conditioning.

V-belt replacement -- the service life of automobile V-belts is from three to five years, depending on conditions of the vehicle's service. The V-belts should be checked frequently to insure their condition. Visually check for cuts, cracks, and/or shredding. This may indicate pulley misalignment. Check proper belt tension. Through use and normal wear, belts are inclined to stretch some. Belts which are cut, cracked, or show excessive shredding should be replaced immediately. Correcting the tension or replacing the belt is relatively easy in that all V-belt drives have one pulley that is adjustable. When replacing these belts much care must be undertaken in the adjustment procedure, as a belt that is too tight is likely to damage generator, water pump, or power steering pump bearings and seals. On the other hand, a loose belt can cause overheating of the engine, poor or no charging from the generator, and loss of power steering. Unless precautions are taken upon installation and adjustment many of these things will result, and possibly more damage to the engine could be created.

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-14(S)

**TASK:** TEST D.C. TYPE CHARGING SYSTEM

**AIM:** THE STUDENT WILL BE ABLE TO INSPECT AND TEST THE COMPONENTS OF A D.C. CHARGING SYSTEM TO DETERMINE NEEDED ADJUSTMENTS OR REPLACEMENT OF SPECIFIC PARTS OF THE CHARGING SYSTEM; USING THE TOOLS AND TEST INSTRUMENTS CALLED FOR IN THE TASK.

**TOOLS AND EQUIPMENT:** AMMETER, VOLTMETER, TACHOMETER, HYDROMETER, HAND TOOLS, FENDER COVERS, JUMPER LEADS, SEAT COVER, DROP LIGHT

**MATERIALS:** CLEAN RAGS

**TEACHING AIDS:** WIRING DIAGRAMS, TRANSPARENCIES I ED II 7T, 192-194, 226-229, 231-234, 237-241; VIII-C-14(J) AND TASK SHEETS

**REFERENCES:**
AUTOMECHANICS, CH. 19
AUTOMOTIVE ENCYCLOPEDIA, P. 329
AUTO SERVICE AND REPAIR, CH. 22
AUTOMOTIVE MECHANICS, CH. 25

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENTS MUST HAVE SATISFACTORILY COMPLETED PRECEDING TASKS IN MAJOR BLOCK VIII. STUDENTS MUST HAVE STUDIED JOB SHEET VIII-C-14(J) AND ACCOMPANYING TASK SHEETS. STUDENTS MUST HAVE EXHIBITED THE ABILITY TO GIVE BACK TO THE INSTRUCTOR INFORMATION TAUGHT IN THE RELATED LESSONS ON ELECTRICITY AND ELECTRICAL COMPONENTS.

**CHECKING STANDARDS:**

1. SELECTION OF TOOLS AND EQUIPMENT
2. OBSERVE SAFETY STANDARDS
3. PREPARATION AND HOOKUP OF TEST EQUIPMENT
4. USE OF TEST EQUIPMENT
5. TEST RESULTS ACCORDING TO SPECIFICATIONS
6. USE OF TOOLS AND EQUIPMENT
7. AN ATTITUDE OR APPRECIATION FOR CUSTOMER'S VEHICLE
8. COOPERATION WITH FELLOW WORKERS AND INSTRUCTOR

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHEN ABNORMAL OPERATION IS NOTED IN A D. C. TYPE CHARGING SYSTEM OF A VEHICLE, IT IS NECESSARY TO MAKE CERTAIN CHECKS TO DETERMINE WHICH OF THE CHARGING SYSTEM COMPONENTS ARE AT FAULT.

## I. PREPARATION (CON'T)

DURING THIS LESSON THE INTENT IS TO DEMONSTRATE A SERIES OF INSPECTIONS AND TESTS WHICH WILL POINT OUT COMPONENTS OF THE AUTOMOBILE CHARGING SYSTEM THAT MAY BE AT FAULT IN PRODUCING, MAINTAINING, AND CONTROLLING ELECTRICAL OUTPUT. HOOKUP OF TEST EQUIPMENT, TESTING PROCEDURES, AND RECOMMENDED CORRECTIVE ACTION FOR EACH TYPE OF FAULT WILL ALSO BE DEMONSTRATED AND DISCUSSED.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. COMPONENTS TO BE TESTED AND INSPECTED | 1. BATTERY<br>2. GENERATOR<br>3. REGULATOR<br>4. WIRING HARNESS |
| 2. VISUAL INSPECTION | ENGINE DEAD |
| A. BATTERY | REFER TO JOB VIII-C-1(TS) |
| B. GENERATOR | 1. CLEAN<br>2. ENGINE TO GENERATOR MOUNTING BOLTS TIGHT<br>3. ELECTRICAL TERMINALS<br>a. TERMINAL NUTS TIGHT<br>b. INSULATION IN GOOD CONDITION<br>4. DRIVE PULLEY<br>a. GRASP PULLEY ON EACH SIDE<br>b. EXERT EFFORT ON PULLEY FROM SIDE TO SIDE TO CHECK FOR BEARING WEAR<br>5. REMOVE DUST COVER FROM HOUSING<br>6. CHECK COMMUTATOR FOR WEAR AND CLEANLINESS<br>7. INSPECT BRUSHES FOR WEAR AND CONTACT WITH COMMUTATOR<br>8. DRIVE BELT<br>a. GRASP DRIVE BELT WITH ONE HAND NEAR CENTER BETWEEN PULLEYS<br>b. TWIST DRIVE BELT<br>c. CHECK FOR CRACKS, MISSING SEGMENTS, GLAZE, WEAR, FLEXIBILITY<br>d. CHECK FOR TENSION |

C. WIRING HARNESS

1. BURNED OR CRYSTALIZED INSULATION
2. CLEAN CONNECTIONS
3. ALL CONNECTIONS TIGHT
4. BROKEN OR CRACKED INSULATION

D. REGULATOR

1. HEAT SPOTS ON COVER
2. COVER NOT BENT, CRACKED, WARPED
3. COVER TIGHT
4. MOUNTING SCREWS TIGHT
5. TERMINAL SCREWS TIGHT

3. NOISE CHECK

1. SET VEHICLE PARK BRAKE
2. PLACE TRANSMISSION IN NEUTRAL
3. START ENGINE
4. GENERATOR
    a. NOISY BEARINGS
    b. ARCING BRUSHES
    c. NOISY BRUSHES
5. DRIVE BELT SQUEAKING
6. STOP ENGINE

4. GENERATOR OUTPUT TEST

1. START ENGINE, ALLOW ALL COMPONENTS OF SYSTEM TO REACH OPERATING TEMPERATURE
2. CHECK THE VEHICLE MANUFACTURER'S SPECIFICATION FOR GENERATOR OUTPUT RATING
3. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES
4. STOP ENGINE
5. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY TERMINAL AND GROUND
6. DISCONNECT REGULATOR "F" TERMINAL LEAD
7. ATTACH JUMPER WIRE TO REGULATOR "F" TERMINAL LEAD
8. ATTACH SECOND END OF JUMPER WIRE TO BASE OF REGULATOR
9. ATTACH SECOND JUMPER LEAD BETWEEN "F" TERMINAL AND "A" TERMINAL ON GENERATOR
10. DISCONNECT "BAT" LEAD FROM REGULATOR
11. CONNECT AMMETER BETWEEN "BAT" TERMINAL ON REGULATOR AND "BAT" DISCONNECTED LEAD

12. START ENGINE
13. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER READING IS 35 AMPERES

    NOTE: RPM OF ENGINE NOT TO EXCEED 1500

14. AFTER MAKING TEST RETURN ENGINE RPM TO IDLE
15. COMPARE GENERATOR OUTPUT WITH MANUFACTURER'S RATED OUTPUT

    NOTE: IF GENERATOR DOES NOT PRODUCE MANUFACTURER'S RATED OUTPUT AT 1500 RPM OR LESS THE GENERATOR IS NOT FUNCTIONING PROPERLY

16. STOP ENGINE

**5. TEST CUTOUT RELAY**

1. TEST LEADS AND AMMETER HOOKUP FOR GENERATOR OUTPUT TEST ARE TO REMAIN ATTACHED
2. CONNECT VOLTMETER BETWEEN "GEN" TERMINAL ON REGULATOR AND TO GROUND ON REGULATOR BASE
3. START ENGINE
4. SLOWLY INCREASE ENGINE RPM
5. OBSERVE AMMETER AND VOLTMETER

    NOTE: CUTOUT RELAY CLOSING VOLTAGE READING INDICATED ON THE VOLTMETER JUST BEFORE THE AMMETER READING INDICATES CHARGE

6. COMPARE VOLTAGE READING WITH MANUFACTURER'S SPECIFICATIONS

    NOTE: IF CLOSING VOLTAGE VARIES FROM SPECIFICATION CUTOUT RELAY SPRING MUST BE ADJUSTED

7. SLOWLY DECREASE ENGINE RPM
8. OBSERVE AMMETER

    NOTE: CUTOUT RELAY COUNTERAMPERAGE IS THE LOWEST AMMETER READING BELOW ZERO, JUST BEFORE THE AMMETER INDICATOR SWINGS TO ZERO

9. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF COUNTERAMPERAGE VARIES FROM SPECIFICATION CUTOUT RELAY AIR GAP AND POINT GAP MUST BE ADJUSTED

10. STOP ENGINE

6. TEST VOLTAGE REGULATOR

1. REMOVE JUMPER LEAD FROM REGULATOR "BASE" AND "F" TERMINAL LEAD
2. RECONNECT "F" TERMINAL LEAD TO "F" TERMINAL ON REGULATOR
3. REMOVE AMMETER FROM REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
4. CONNECT A FIXED RESISTOR OR 1/4 OHM BETWEEN THE REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
5. REMOVE VOLTMETER LEAD TO REGLATOR "BAT" TERMINAL
6. ATTACH VOLTMETER LEAD FROM REGLATOR "BAT" TERMINAL
7. SECOND VOLTMETER LEAD REMAINS GROUNDED TO REGULATOR BASE
8. REMOVE JUMPER LEAD FROM GENERATOR "A" AND "F" TERMINALS
9. TACHOMETER REMAINS ATTACHED AS IN GENERATOR TEST
10. START ENGINE
11. INCREASE ENGINE RPM TO 2000
12. OBSERVE VOLTMETER READING
13. STOP ENGINE
14. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF VOLTMETER READING DOES NOT FALL INTO THE SPECIFIED LIMIT, VOLTAGE REGULATOR SPRING TENSION MUST BE ADJUSTED

EXAMPLE: VOLTMETER READING SPECIFIED RANGE BETWEEN 13.5 AND 14.7 VOLTS

7. TEST CURRENT REGULATOR

1. VOLTMETER TO REMAIN ATTACHED AS IN VOLTAGE REGULATOR TEST

2. REMOVE RESISTOR FROM REGULATOR "BAT" TERMINAL AND "BAT" TERMINAL LEAD
3. CONNECT AMMETER BETWEEN REGULATOR "BAT" TERMINAL AND VARIABLE LOAD CARBON PILE
4. CONNECT VARIABLE LOAD CARBON PILE ACROSS BATTERY, ONE LEAD CONNECTED TO "BAT" TERMINAL LEAD, GROUND SECOND LEAD
5. TURN CARBON PILE SWITCH ON AND TO LOWEST LOAD
6. START ENGINE
7. SET ENGINE RPM AT 1500
8. SLOWLY APPLY LOAD TO BATTERY WITH CARBON PILE
9. OBSERVE THE AMMETER FOR HIGHEST READING
10. STOP ENGINE
11. TURN CARBON PILE SWITCH OFF
12. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS

NOTE: IF CURRENT REGULATOR SETTING DOES NOT READILY COMPARE WITH SPECIFICATIONS, ADJUST CURRENT REGULATOR
EXAMPLE: CURRENT OUTPUT MAY BE BETWEEN 34 AND 38 AMPERES

13. REMOVE ALL TEST EQUIPMENT
14. CONNECT "BAT" LEAD TO REGULATOR "BAT" TERMINAL

8. TEST INSULATED CIRCUIT RESISTANCE

1. CONNECT AN AMMETER BETWEEN THE REGULATOR "BAT" TERMINAL AND THE BATTERY
2. CONNECT A VOLTMETER BETWEEN THE BATTERY INSULATED TERMINAL AND THE GENERATOR "A" TERMINAL
3. START THE ENGINE
4. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
5. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED 1 VOLT. IF VOLTAGE LOSS IS

MORE THAN 1 VOLT ISOLATE EACH WIRE IN THE CHARGING SYSTEM AND EACH REGULATOR TERMINAL ONE AT A TIME. VOLTAGE LOSS FOR EACH COMPONENT SHOULD NOT EXCEED .2 VOLT

6. STOP ENGINE

9. TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE

1. REMOVE VOLTMETER LEADS FROM THE GENERATOR "A" TERMINAL AND BATTERY INSULATED TERMINAL
2. CONNECT VOLTMETER BETWEEN GENERATOR MOUNTING BRACKET AND BATTERY GROUND POST
3. AMMETER REMAINS CONNECTED AS IN INSULATED CIRCUIT TEST
4. START ENGINE
5. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
6. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. IF VOLTAGE LOSS IS GREATER THAN .2 BATTERY TO ENGINE GROUND IS BAD OR GENERATOR TO ENGINE GROUND IS BAD

7. STOP ENGINE

10. TEST REGULATOR GROUND CIRCUIT RESISTANCE

1. REMOVE VOLTMETER LEADS FROM GENERATOR MOUNTING BRACKET AND BATTERY GROUND TERMINAL
2. CONNECT VOLTMETER BETWEEN REGULATOR BASE AND GENERATOR MOUNTING BRACKET
3. START ENGINE
4. INCREASE ENGINE RPM UNTIL AMMETER INDICATES 20 AMPERE CHARGE
5. OBSERVE VOLTMETER READING

NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. VOLTAGE LOSS ABOVE .2 VOLT WILL AFFECT CUTOUT RELAY AND VOLTAGE REGULATOR CAUSING THEM TO FUNCTION AT A HIGHER SETTING THAN THE ACTUAL ADJUSTMENT

6. STOP ENGINE
7. REMOVE TEST EQUIPMENT

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## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

STUDENTS TO PRACTICE ON THE JOB UNDER CLOSE SUPERVISION. STUDENTS TO BE FURNISHED WITH JOB AND TASK SHEETS TO FOLLOW WHILE PERFORMING THIS JOB. STUDENTS SHOULD CHECK WITH INSTRUCTOR AT FREQUENT INTERVALS.

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## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM JOB. USE PERFORMANCE TEST.

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## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

EMPHASIZE TYPES OF TESTS

1. VISUAL
2. AUDIO
3. GENERATOR OUTPUT
4. CUTOUT RELAY
5. VOLTAGE REGULATOR
6. CURRENT REGULATOR
7. INSULATED CIRCUIT RESISTANCE
8. CHARGING SYSTEM GROUND CIRCUIT RESISTANCE
9. REGULATOR GROUND CIRCUIT RESISTANCE

REPEAT TEST EQUIPMENT HOOKUP FOR EACH TEST.

EMPHASIZE CAUTION CONCERNING POSSIBLE DAMAGE TO GENERATOR AND REGULATOR DURING TESTS.

EMPHASIZE SAFETY.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN, P.
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP.
AUTO SERVICE AND REPAIR, STOCKEL
AUTOMOTIVE MECHANICS, CROUSE

THE NEXT LESSON IS: VIII-C-15(S) "TEST A.C. TYPE CHARGING SYSTEM"

VIII-C-14(J)

## JOB SHEET
## IN
## CHARGING SYSTEM

JOB: TEST D.C. CHARGING SYSTEM

MATERIALS: CLEAN RAGS

TOOLS AND EQUIPMENT: AMMETER, VOLTMETER, HYDROMETER, HAND TOOLS, FENDER COVER, SEAT COVERS, JUMPER LEADS, DROP LIGHT, TACHOMETER, 1/4 OHM RESISTOR, VARIABLE LOAD CARBON PILE

GENERAL INSTRUCTIONS: BEFORE STARTING THIS JOB READ REFERENCE MATERIAL. STUDY JOB AND TASK SHEETS. BE SURE FENDER COVERS ARE IN POSITION ON THE VEHICLE BEFORE STARTING THE JOB. THE JOB IS TO LOCATE THE CHARGING SYSTEM PART WHICH MAY NEED SERVICE, REPAIR, OR REPLACEMENT. BE PRECISE IN ALL TEST PROCEDURES IN ORDER TO GET TRUE READINGS FROM THE TEST INSTRUMENTS. DISCUSS TEST RESULTS WITH INSTRUCTOR AND DETERMINE NEEDED MAINTENANCE TO CORRECT CHARGING SYSTEM PROBLEMS.

PROCEDURES AND/OR TASKS:

| | |
|---|---|
| VIII-C-14(TS) | INSPECT CHARGING SYSTEM |
| VIII-C-14a(TS) | TEST GENERATOR OUTPUT |
| VIII-C-14b(TS) | TEST CUTOUT RELAY |
| VIII-C-14c(TS) | TEST VOLTAGE REGULATOR |
| VIII-C-14d(TS) | TEST CURRENT REGULATOR |
| VIII-C-14e(TS) | TEST INSULATED CIRCUIT RESISTANCE |
| VIII-C-14f(TS) | TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE |
| VIII-C-14g(TS) | TEST REGULATOR GROUND CIRCUIT RESISTANCE |

CHECK POINT: CHECK WITH INSTRUCTOR FOR CORRECT TEST EQUIPMENT HOOKUP AND TEST RESULTS

SERVICE STORAGE BATTERY
CLEAN WORK STATION

## TASK SHEET

VIII-C-14(TS)

TASK: INSPECT CHARGING SYSTEM

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, FENDER COVER, DROPLIGHT, SEAT COVER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. OPEN HOOD<br>2. PLACE FENDER COVERS OVER FENDERS<br>3. POSITION DROPLIGHT<br>a. UNDER HOOD<br>b. PLUGGED INTO POWER OUTLET<br>c. TURNED ON<br>4. PLACE SEAT COVER OVER DRIVER'S SEAT<br>5. SET PARK BRAKE<br>6. PLACE TRANSMISSION IN NEUTRAL |
| 3. VISUALLY INSPECT BATTERY | AS IN VIII-C-1(TS) |
| 4. VISUALLY INSPECT GENERATOR | 1. CLEAN CONDITION<br>2. GENERATOR TO THE ENGINE MOUNTING BOLTS TIGHT<br>3. ELECTRICAL TERMINALS<br>a. TERMINAL NUTS TIGHT<br>b. TERMINAL INSULATION IN GOOD CONDITION<br>4. DRIVE PULLEY<br>a. GRASP PULLEY ON EACH SIDE<br>b. EXTEND PRESSURE ON THE PULLEY FROM SIDE TO SIDE, CHECK FOR BEARING WEAR<br>5. REMOVE DUST COVER FROM HOUSING<br>6. CHECK COMMUTATOR FOR WEAR AND CLEANLINESS<br>7. INSPECT BRUSHES FOR WEAR AND CONTACT WITH COMMUTATOR |

| STEPS | KEY POINTS |
|---|---|
| | 8. CHECK BRUSH SPRING TENSION |
| 5. VISUALLY INSPECT DRIVE BELT | 1. CHECK FOR PROPER TENSION ADJUSTMENT |
| | 2. CHECK BELT GENERAL CONDITION |
| | a. GRASP BELT NEAR CENTER BETWEEN PULLEYS |
| | b. TWIST BELT EXPOSING BOTTOM SIDE |
| | c. CHECK FOR CRACKS, MISSING SEGMENTS, WEAR, GLAZE, FLEXIBILITY |
| | 3. RELEASE BELT |
| 6. VISUALLY INSPECT WIRING SYSTEM | 1. BURNED OR CRYSTALIZED INSULATION |
| | 2. BROKEN OR CRACKED INSULATION |
| | 3. BROKEN WIRES |
| | 4. TERMINALS FIRMLY ATTACHED TO THE WIRES |
| | 5. CLEAN CONDITION |
| | 6. CONNECTIONS TIGHT AT ALL TERMINAL POINTS |
| 7. VISUALLY INSPECT REGULATOR | 1. LOOK FOR HEAT SPOTS ON COVER |
| | 2. LOOK FOR DENTS AND DEPRESSIONS IN COVER |
| | 3. COVER TIGHT |
| | 4. MOUNTING SCREWS TIGHT |
| | 5. TERMINAL SCREWS TIGHT |
| 8. NOISE CHECK | 1. START ENGINE |
| | 2. CHECK GENERATOR FOR NOISY BEARINGS |
| | 3. CHECK THE GENERATOR FOR NOISY BRUSHES |
| | 4. CHECK THE GENERATOR FOR ARCING BRUSHES |
| | 5. CHECK BELT DRIVE FOR SQUEAKING |
| | 6. STOP ENGINE |
| | 7. REPLACE DUST COVER ON GENERATOR |
| 9. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-14a(TS)

**TASK:** TEST GENERATOR OUTPUT

**JOB:** TEST D.C. CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** AMMETER, VOLTMETER, JUMPER LEADS, HAND TOOLS, FENDER COVERS, SEAT COVER, DROPLIGHT, TACHOMETER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | 1. AS IN PREVIOUS TASKS<br>2. START ENGINE, ALLOW ALL CHARGING SYSTEM COMPONENTS TO REACH THE OPERATING TEMPERATURE<br>3. STOP ENGINE |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR THE GENERATOR OUTPUT RATING<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BE DAMAGED |
| B. CONNECT JUMPER LEADS | 1. REMOVE TERMINAL LEAD FROM REGULATOR "F" TERMINAL<br>2. ATTACH JUMPER LEAD TO "F" TERMINAL LEAD<br>3. ATTACH SECOND END OF JUMPER LEAD TO BASE OF REGULATOR, MAKING A GROUND<br>4. CONNECT SECOND JUMPER LEAD BETWEEN "A" AND "F" TERMINALS ON GENERATOR |
| C. CONNECT AMMETER | 1. REMOVE TERMINAL LEAD FROM REGULATOR "BAT" TERMINAL |

| STEPS | KEY POINTS |
|---|---|
| | 2. ATTACH ONE AMMETER LEAD TO REGULATOR "BAT" TERMINAL |
| | 3. ATTACH SECOND AMMETER LEAD TO REGULATOR "BAT" TERMINAL LEAD |
| | 4. POSITION AMMETER WHERE IT CAN BE READILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BECOME DAMAGED |
| 4. TEST GENERATOR OUTPUT | 1. START ENGINE |
| | 2. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER READING IS 35 AMPERES |
| | NOTE: ENGINE RPM IS NOT TO EXCEED 1500 |
| | 3. STOP ENGINE IMMEDIATELY AFTER TEST HAS BEEN PERFORMED |
| | 4. COMPARE GENERATOR TEST OUTPUT WITH MANUFACTURER'S RATED OUTPUT |
| | NOTE: IF GENERATOR DOES NOT PRODUCE MANUFACTURER'S RATED OUTPUT AT 1500 RPM OR LESS IT IS NOT FUNCTIONING PROPERLY AND MUST BE REPLACED OR SERVICED |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. CONNECT ALL LEADS TO PROPER POSITION |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-14b(TS)

TASK: TEST CUTOUT RELAY

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, AMMETER, FENDER COVERS, SEAT COVERS, JUMPER LEADS, DROPLIGHT, HAND TOOLS, TACHOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. CONNECT TEST INSTRUMENTS | 1. REFER TO TASK VIII-C-14a(TS)<br>2. CONNECT VOLTMETER BETWEEN REGULATOR "GEN" TERMINAL AND TO THE GROUND ON REGULATOR BASE |
| 4. TEST CUTOUT RELAY | 1. START ENGINE<br>2. SLOWLY INCREASE ENGINE RPM<br>3. OBSERVE AMMETER AND VOLTMETER<br>NOTE: CUTOUT RELAY CLOSING VOLTAGE IS THE HIGHEST VOLTAGE READING INDICATED ON THE VOLTMETER INDICATES CHANGE<br>4. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS<br>NOTE: IF CLOSING VOLTAGE VARIES FROM SPECIFICATIONS, CUTOUT RELAY SPRING TENSION MUST BE ADJUSTED<br>5. SLOWLY DECREASE ENGINE RPM<br>6. OBSERVE AMMETER<br>NOTE: CUTOUT RELAY COUNTERAMPERAGE IS THE LOWEST AMMETER READING BELOW ZERO, JUST BEFORE THE AMMETER INDICATOR SWINGS TO ZERO<br>7. STOP ENGINE<br>8. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: IF COUNTERAMPERAGE VARIES FROM SPECIFICATIONS, CUTOUT RELAY AIR GAP AND POINT GAP MUST BE ADJUSTED |
| | 9. REMOVE TEST EQUIPMENT |
| | 10. CONNECT ALL LEADS TO THE PROPER POSITION |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

# TASK SHEET

VIII-C-14c(TS)

TASK: TEST VOLTAGE REGULATOR

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, FENDER COVERS, SEAT COVER, 1/4 OHM FIXED RESISTOR, TACHOMETER, DROPLIGHT

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR VOLTAGE REGULATOR SETTING<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BE DAMAGED |
| B. CONNECT RESISTOR | 1. REMOVE TERMINAL LEAD FROM REGULATOR "BAT" TERMINAL<br>2. CONNECT ONE LEAD OF A 1/4 OHM FIXED RESISTOR TO THE "BAT" REGULATOR TERMINAL<br>3. CONNECT SECOND LEAD OF THE 1/4 OHM RESISTOR TO THE "BAT" TERMINAL LEAD |
| C. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO THE REGULATOR "BAT" TERMINAL WITH THE RESISTOR<br>2. CONNECT SECOND LEAD OF THE VOLTMETER TO REGULATOR BASE<br>3. POSITION VOLTMETER WHERE IT CAN BE READILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BECOME DAMAGED |

| STEPS | KEY POINTS |
|---|---|
| 4. TEST VOLTAGE REGULATOR | 1. START ENGINE<br>2. INCREASE ENGINE RPM TO 2000<br>3. OBSERVE VOLTMETER READING<br>4. STOP ENGINE<br>5. COMPARE VOLTMETER READING WITH MANUFACTURER'S SPECIFICATIONS<br>NOTE: IF VOLTMETER READING DOES NOT FALL INTO THE SPECIFIED LIMIT, VOLTAGE REGULATOR SPRING TENSION MUST BE ADJUSTED<br>EXAMPLE: VOLTMETER READING SPECIFIED RANGE MAY BE BETWEEN 13.5 AND 14.7 VOLTS<br>6. REMOVE TEST EQUIPMENT<br>7. CONNECT ALL THE CHARGING SYSTEM LEADS TO PROPER TERMINALS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

# TASK SHEET

VIII-C-14d(TS)

| | |
|---|---|
| TASK: | TEST CURRENT REGULATOR |
| JOB: | TEST D.C. CHARGING SYSTEM |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | VOLTMETER, AMMETER, TACHOMETER, VARIABLE LOAD CARBON PILE, FENDER COVERS, SEAT COVERS, DROPLIGHT, HAND TOOLS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. CONNECT TEST INSTRUMENTS | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CURRENT REGULATOR SETTINGS<br>2. CHECK TEST EQUIPMENT, MANUFACTURER'S TESTER HOOKUPS, AND RECOMMENDED TEST PROCEDURES |
| A. CONNECT TACHOMETER | 1. CONNECT ONE LEAD TO DISTRIBUTOR PRIMARY TERMINAL<br>2. CONNECT SECOND LEAD TO GROUND<br>3. POSITION TACHOMETER WHERE IT CAN BE EASILY OBSERVED AND OUT OF THE WAY SO THAT IT WILL NOT BECOME DAMAGED |
| B. CONNECT VOLTMETER | 1. DISCONNECT REGULATOR "BAT" TERMINAL LEAD<br>2. CONNECT ONE VOLTMETER LEAD TO REGULATOR "BAT" TERMINAL<br>3. CONNECT SECOND VOLTMETER LEAD TO BASE OF REGULATOR<br>4. POSITION VOLTMETER WHERE IT CAN BE READILY OBSERVED BUT OUT OF THE WAY |
| C. CONNECT CARBON PILE | 1. CONNECT ONE LEAD OF THE VARIABLE LOAD CARBON PILE TO "BAT" TERMINAL READ<br>2. CONNECT SECOND LEAD OF VARIABLE CARBON PILE TO GROUND |

| STEPS | KEY POINTS |
|---|---|
| | 3. POSITION CARBON PILE OUT OF WAY BUT HANDY |
| D. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL |
| | 2. CONNECT SECOND LEAD OF AMMETER TO TERMINAL ON CARBON PILE WHERE "BAT" TERMINAL LEAD IS ATTACHED |
| | 3. POSITION AMMETER WHERE IT CAN BE READILY OBSERVED BUT OUT OF THE WAY |
| 4. TEST CURRENT REGULATOR | 1. TURN CARBON PILE SWITCH TO LOWEST LOAD |
| | 2. START ENGINE |
| | 3. SET ENGINE RPM AT 1500 |
| | 4. SLOWLY APPLY LOAD TO BATTERY WITH CARBON PILE |
| | 5. OBSERVE THE AMMETER FOR HIGHEST READING |
| | 6. STOP ENGINE |
| | 7. TURN CARBON PILE SWITCH OFF |
| | 8. COMPARE AMMETER READING WITH MANUFACTURER'S SPECIFICATIONS |
| | NOTE: IF CURRENT REGULATOR SETTING DOES NOT READILY COMPARE WITH SPECIFICATIONS ADJUST CURRENT REGULATOR<br>EXAMPLE: CURRENT OUTPUT MAY BE BETWEEN 34 AND 38 AMPERES |
| | 9. REMOVE TEST INSTRUMENTS |
| | 10. CONNECT ALL LEADS TO PROPER TERMINAL |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-C-14e(TS)

TASK: TEST INSULATED CIRCUIT RESISTANCE

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVERS, DROPLIGHT, VOLTMETER, AMMETER, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK VIII-C-14a(TS) |
| A. CONNECT AMMETER | 1. CONNECT ONE AMMETER LEAD TO THE REGULATOR "BAT" TERMINAL |
| | 2. CONNECT SECOND AMMETER LEAD TO BATTERY INSULATED TERMINAL |
| | 3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT VOLTMETER | 1. CONNECT ONE VOLTMETER LEAD TO BATTERY INSULATED TERMINAL |
| | 2. CONNECT SECOND VOLTMETER LEAD TO GENERATOR "A" TERMINAL |
| | 3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST INSULATED CIRCUIT | 1. FOR RESISTANCE |
| | 2. START ENGINE |
| | 3. INCREASE ENGINE RPM SLOWLY UNTIL AMMETER INDICATES THE 20 AMPERE CHARGE |
| | 4. OBSERVE VOLTMETER READING |
| | NOTE: VOLTAGE LOSS IS NOT TO EXCEED 1 VOLT. IF VOLTAGE LOSS IS GREATER THAN 1 VOLT, USE VOLTMETER, ISOLATE EACH WIRE AND EACH REGULATOR TERMINAL IN THE CHARGING SYSTEM ONE AT A TIME. VOLTAGE LOSS FOR EACH COMPONENT SHOULD NOT EXCEED .2 VOLT |

| STEPS | KEY POINTS |
|---|---|
| | 5. STOP ENGINE |
| | 6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

TASK SHEET VIII-C-14f(TS)

TASK: TEST CHARGING SYSTEM GROUND CIRCUIT RESISTANCE

JOB: TEST D.C. CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VOLTMETER, AMMETER, FENDER COVERS, SEAT COVER, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK VIII-C-14a(TS) |
| A. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO GENERATOR MOUNTING BRACKET<br>2. CONNECT SECOND VOLTMETER LEAD TO BATTERY GROUND TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL<br>2. CONNECT SECOND LEAD OF AMMETER TO BATTERY INSULATED TERMINAL<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST CHARGING SYSTEM GROUND CIRCUIT | 1. FCR RESISTANCE<br>2. START ENGINE<br>3. INCREASE ENGINE RPM SLOWLY UNTIL THE AMMETER INDICATES 20 AMPERE CHARGE<br>4. OBSERVE VOLTMETER READING<br>NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. IF VOLTAGE LOSS IS GREATER THAN .2 VOLT BATTERY TO ENGINE GROUND IS BAD OR GENERATOR TO ENGINE GROUND IS BAD<br>5. STOP ENGINE<br>6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## TASK SHEET

VIII-C-14g(TS)

**TASK:** TEST REGULATOR GROUND CIRCUIT RESISTANCE

**JOB:** TEST D.C. CHARGING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** VOLTMETER, AMMETER, FENDER COVERS, SEAT COVER, DROPLIGHT, HAND TOOLS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PRECEDING TASKS |
| 2. PREPARE VEHICLE | AS IN PRECEDING TASKS |
| 3. CONNECT TEST INSTRUMENTS | REFER TO TASK |
| A. CONNECT VOLTMETER | 1. CONNECT ONE LEAD OF VOLTMETER TO GENERATOR MOUNTING FRAME<br>2. CONNECT SECOND VOLTMETER LEAD TO REGULATOR BASE<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| B. CONNECT AMMETER | 1. CONNECT ONE LEAD OF AMMETER TO REGULATOR "BAT" TERMINAL<br>2. CONNECT SECOND LEAD OF AMMETER TO BATTERY INSULATED BATTERY<br>3. MAKE SURE BOTH CONNECTIONS ARE SECURE AND MAKING GOOD CONTACT |
| 4. TEST REGULATOR GROUND CIRCUIT | 1. FOR RESISTANCE<br>2. START ENGINE<br>3. SLOWLY INCREASE ENGINE RPM UNTIL AMMETER INDICATES THE 20 AMPERE CHARGE<br>4. OBSERVE VOLTMETER READING<br>NOTE: VOLTAGE LOSS IS NOT TO EXCEED .2 VOLT. VOLTAGE LOSS ABOVE .2 VOLT WILL AFFECT CUTOUT RELAY AND REGULATOR SETTINGS. GREATER VOLTAGE LOSS WILL CAUSE THEM TO FUNCTION AT A HIGHER SETTING THAN THE ACTUAL ADJUSTMENT<br>5. STOP ENGINE |

| STEPS | KEY POINTS |
|---|---|
| | 6. REMOVE TEST INSTRUMENTS |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

VIII-C-15(S)

| | |
|---|---|
| TASK: | TEST A.C. TYPE CHARGING SYSTEM |
| AIM: | THE STUDENT WILL BE ABLE TO TEST AND DIAGNOSE A.C. CHARGING SYSTEM COMPONENTS USING REQUIRED TEST EQUIPMENT AND MANUFACTURER'S SPECIFICATIONS AND MAKE JUDGEMENTS AND DECISIONS CONCERNING NEEDED SERVICE OR REPAIR |
| TOOLS AND EQUIPMENT: | FENDER COVERS, SEAT COVER, DROPLIGHT, AMMETER, VOLTMETER, BELT ADJUSTING GAUGE, TACHOMETER, PRY BAR, HAND TOOLS, REGULATOR, THERMOMETER, BATTERY TESTER |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | JOB AND TASK SHEETS, TRANSPARENCIES I ED II 7T, FIGS. 192-194, 226-229, 231-234, 237-241 |
| REFERENCES: | AUTOMECHANICS, PP. 272-277<br>AUTOMOTIVE ENCYCLOPEDIA, PP. 348-351<br>AUTO SERVICE AND REPAIR, PP. 22-22 TO 22-26<br>AUTOMOTIVE MECHANICS, PP. 226-236, 357-359 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST BE ABLE TO IDENTIFY THE PARTS OF AN A.C. CHARGING SYSTEM, MUST HAVE READ THE REFERENCES, AND HAVE STUDIED THE JOB AND TASK SHEETS. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT<br>2. TEST EQUIPMENT HOOKUP<br>3. CRAFTSMANLIKE PERFORMANCE OF TASK<br>4. ACCURACY OF TEST RESULTS<br>5. APPRECIATION FOR TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE<br>6. SAFE WORKING HABITS |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

NORMAL OPERATION FAILURE OF AN ALTERNATOR IS NOTED THROUGH SEVERAL DIFFERENT TYPES AND KINDS OF SYMPTOMS.

THE ALTERNATOR WILL HUM OR WHINE AT LOW SPEEDS OR IDLE WHEN A DIODE IS DEFECTIVE. AN ALTERNATOR IS A THREE-PHASE MACHINE; THEREFORE, WHEN A DIODE IS DEFECTIVE THE ALTERNATOR IS OUT OF SOUND PHASE, CAUSING THE HUM OR WHINE. THIS CAN BE THE RESULT OF A SHORTED DIODE.

AN OPEN DIODE CAUSES THE UNIT TO BECOME ELECTRICALLY UNBALANCED,

## I. PREPARATION (CON'T)

THEREBY CAUSING A PHYSICAL UNBALANCE OF THE UNIT. WHEN AN ALTERNATOR OPERATES UNDER THESE CONDITIONS IT IS NOISY. IF THIS CONDITION IS NOT CORRECTED THE DIODE END FRAME BUSHINGS OR BEARINGS WILL BECOME DAMAGED.

AN ALTERNATOR WITH FAULTY DIODES CAN SUPPLY THE IGNITION SYSTEM WITH SUFFICIENT CURRENT BUT WILL NOT BE ADEQUATE WHEN OTHER ELECTRICAL APPARATUS IS USED.

THE USUAL ALTERNATOR PROBLEM IS IN THE DIODES. DIODE PROBLEMS ARE USUALLY CREATED BY CARELESS OR UNSKILLED PRACTICES.

USUAL TESTS TO BE USED ON THE ALTERNATOR SYSTEM CONSIST OF:

1. BELT TENSION
2. BATTERY CONDITION
3. CIRCUIT TESTS
4. ALTERNATOR
    a. FIELD CURRENT DRAW TEST
    b. OUTPUT TEST
5. REGULATOR TEST

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION THE VEHICLE AS IN PRECEDING TASKS<br>2. RAISE THE HOOD AND INSTALL FENDER COVERS |
| 2. CHECK DRIVE BELT | 1. GENERAL CONDITION AS IN D.C. GENERATOR<br>2. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT BELT TENSION<br>NOTE: ALTERNATOR DRIVE BELT TENSION IS CRITICAL BECAUSE THE DRIVE PULLEY IS SMALL AND HAS LITTLE WRAP AROUND DRIVE BELT ACTION. TOO LOOSE BELT WILL SLIP. TOO TIGHT END FRAME BEARING IS DAMAGED<br>3. LOOSEN SUPPORT BRACKET BOLTS<br>4. LOOSEN BELT ADJUSTING BOLT<br>5. PLACE PRY BAR BETWEEN ENGINE AND |

| | |
|---|---|
| | HEAVY FRONT SECTION OF ALTERNATOR HOUSING<br>CAUTION: CARE MUST BE TAKEN NOT TO CRUSH THE ALTERNATOR HOUSING WITH THE PRY BAR<br>6. TIGHTEN BELT BY PRYING ALTERNATOR AWAY FROM ENGINE<br>7. HOLD BAR WITH ONE HAND<br>8. DEPRESS CENTER OF BELT BETWEEN PULLEYS WITH OTHER HAND<br>9. ESTIMATE ONE-HALF INCH DEPRESSION<br>10. TIGHTEN BELT ADJUSTMENT BOLT<br>11. USE BELT ADJUSTING GAUGE FOR SPECIFIED TENSION CHECK<br>12. TIGHTEN SUPPORT BRACKET BOLTS |
| 3. CHECK BATTERY CONDITIONS | REFER TO JOB VIII-C-1(J) |
| 4. FIELD CIRCUIT RESISTANCE TEST | 1. REMOVE BATTERY GROUND TERMINAL LEAD<br>2. REMOVE IGNITION WIRE AT COIL SIDE OF BALLAST RESISTOR<br>3. CONNECT NEGATIVE VOLTMETER LEAD TO FIELD TERMINAL OF REGULATOR AND POSITIVE LEAD TO POSITIVE POST OF BATTERY<br>NOTE: ALL ACCESSORIES AND LIGHTS ARE TO BE TURNED OFF<br>4. REPLACE BATTERY GROUND LEAD<br>5. TURN IGNITION SWITCH ON<br>6. TAKE READING FROM VOLTMETER<br>NOTE: VOLTAGE READING IS NOT TO EXCEED .55 VOLT. A READING ABOVE .55 VOLT INDICATES HIGH RESISTANCE IN FIELD CIRCUIT BETWEEN REGULATOR FIELD TERMINAL AND BATTERY<br>7. IF HIGH RESISTANCE IS INDICATED MOVE NEGATIVE VOLTMETER LEAD TO EACH TERMINAL IN THE CIRCUIT TO THE BATTERY<br>NOTE: IF THERE IS A SUDDEN DROP IN |

THE VOLTAGE READING THERE IS A LOOSE OR CORRODED TERMINAL BETWEEN THE TERMINAL BEING TESTED AND THE PRECEDING TERMINAL

8. MOVE THE NEGATIVE VOLTMETER LEAD BACK TO THE NEXT TERMINAL
    a. GRASP THE TERMINAL BEING TESTED AND ATTEMPT TO MOVE IT
    b. WATCH THE VOLTMETER

    NOTE: ANY MOVEMENT OF THE VOLTMETER NEEDLE INDICATES A LOOSE TERMINAL OR IT IS MAKING PARTIAL CONTACT THROUGH THE CORROSION

    c. TIGHTEN OR CLEAN TERMINAL
9. TURN OFF IGNITION
10. REMOVE BATTERY NEGATIVE TERMINAL LEAD
11. DISCONNECT VOLTMETER
12. CONNECT IGNITION PRIMARY LEAD TO BALLAST RESISTOR TERMINAL

5. CHARGING CIRCUIT RESISTANCE TEST

1. DISCONNECT "BAT" LEAD FROM ALTERNATOR OUTPUT TERMINAL
2. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND "BAT" LEAD
3. CONNECT POSITIVE LEAD OF VOLTMETER TO "BAT" LEAD
4. CONNECT NEGATIVE LEAD OF VOLTMETER TO BATTERY POSITIVE POST
5. DISCONNECT FIELD LEAD FROM ALTERNATOR TO VOLTAGE REGULATOR AT ALTERNATOR
6. CONNECT JUMPER LEAD FROM ALTERNATOR FIELD TERMINAL TO GROUND
7. TACHOMETER BETWEEN PRIMARY DISTRIBUTOR LEAD AND GROUND
8. CONNECT BATTERY NEGATIVE GROUND LEAD
9. TURN CARBON PILE SWITCH TO OFF POSITION
10. CONNECT CARBON PILE SWITCH BETWEEN BATTERY TERMINALS

11. START ENGINE
12. RUN ENGINE AT IDLE SPEED
13. ADJUST ENGINE RPM AND CARBON PILE SWITCH
    a. TO MAINTAIN 20 AMPERE FLOW IN CHARGING SYSTEM
    b. VOLTMETER READING IS NOT TO EXCEED .7 VOLT

NOTE: IF VOLTMETER READING IS ABOVE .7 VOLT INSPECT, CLEAN, AND TIGHTEN ALL CHARGING CIRCUIT CONNECTIONS

NOTE: PERFORM VOLTAGE DROP TEST AT EACH TERMINAL TO LOCATE TERMINAL WITH EXCESSIVE RESISTANCE

14. IDLE ENGINE
15. TURN OFF CARBON PILE SWITCH
16. STOP ENGINE
17. DISCONNECT BATTERY NEGATIVE LEAD
18. REMOVE ALL TEST EQUIPMENT
19. CONNECT FIELD WIRE TO ALTERNATOR FIELD TERMINAL

6. ALTERNATOR CURRENT OUTPUT TEST

NOTE: TEST IS PERFORMED TO DEMINE THAT ALTERNATOR WILL DELIVER RATED CURRENT OUTPUT

1. REMOVE "BAT" LEAD AT ALTERNATOR OUTPUT TERMINAL
2. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND "BAT" LEAD
3. CONNECT VOLTMETER POSITIVE LEAD TO ALTERNATOR "BAT" TERMINAL
4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND
5. REMOVE ALTERNATOR TO VOLTAGE REGULATOR FIELD LEAD AT ALTERNATOR
6. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL AND GOOD GROUND
7. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY LEAD AND GOOD

GROUND

8. TURN CARBON PILE SWITCH TO OFF
9. CONNECT CARBON PILE BETWEEN BATTERY TERMINALS
10. CONNECT BATTERY NEGATIVE LEAD
11. START ENGINE AND RUN AT IDLE RPM
12. GRADUALLY INCREASE ENGINE SPEED TO 1250 RPM
13. ADJUST CARBON PILE UNTIL VOLTMETER READING IS 15 VOLTS

CATUION: VOLTMETER IS NOT TO REACH A READING ABOVE 16 VOLTS

14. CHECK MANUFACTURER'S SPECIFICATIONS FOR ALTERNATOR OUTPUT LIMITS

NOTE: IF AMMETER READING IS LESS THAN SPECIFIED LIMITS ALTERNATOR SHOULD BE REMOVED FROM THE VEHICLE AND BENCH TESTED

15. TURN OFF CARBON PILE SWITCH
16. ADJUST ENGINE IDLE RPM
17. STOP ENGINE
18. REMOVE BATTERY NEGATIVE LEAD
19. REMOVE TEST EQUIPMENT
20. CONNECT "BAT" LEAD TO ALTERNATOR "BAT" TERMINAL
21. CONNECT FIELD LEAD TO ALTERNATOR

7. ELECTRONIC VOLTAGE REGULATOR TEST

1. REMOVE BATTERY TERMINAL LEADS
2. THOROUGHLY CLEAN AND SERVICE BATTERY POSTS AND LEAD CONNECTORS
3. CONNECT VOLTMETER POSITIVE LEAD TO IGNITION NUMBER ONE TERMINAL AT BALLAST RESISTOR
4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND
5. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY LEAD AND A GOOD GROUND
6. CONNECT BATTERY LEADS TO BATTERY
7. START ENGINE

8. SET ENGINE SPEED AT 1250 RPM

NOTE: NO LIGHTS OR ACCESSORIES ARE TO BE ON

9. CHECK MANUFACTURER'S SPECIFICATIONS FOR AMBIENT AIR TEMPERATURE AND CORRESPONDING VOLTAGE READING LIMITS

**A. VOLTAGE READING BELOW SPECIFICATIONS TEST**

1. STOP ENGINE
2. MAKE REGULATOR GROUND TEST, USE TASK SHEET
3. TURN OFF IGNITION SWITCH
4. DISCONNECT REGULATOR CONNECTOR
5. TURN ON IGNITION SWITCH, ENGINE IS NOT TO BE STARTED
6. CHECK FOR BATTERY VOLTAGE
   a. USE VOLTMETER
   b. PROBE BOTH WIRING HARNESS TERMINALS

NOTE: NO VOLTAGE PRESENT AT BOTH LEADS REPLACE REGULATOR

7. CONNECT TO REGULATOR CONNECTOR

**B. VOLTAGE READING HIGHER THAT SPECIFICATIONS TEST**

1. MAKE REGULATOR GROUND TEST, USE TASK SHEET
2. MAKE SYSTEM GROUND CIRCUIT TEST, USE TASK SHEET

NOTE: SYSTEM AND REGULATOR HAVE PROPER GROUND, PROBLEM IS INTERNAL AND VOLTAGE REGULATOR MUST BE REPLACED

3. REMOVE TEST EQUIPMENT

NOTE: ALL OTHER REGULATOR TESTS ARE MADE THE SAME AS FOR A D.C. CHARGING SYSTEM

**8. ROTOR FIELD COIL DRAW TEST**

1. DISCONNECT BATTERY NEGATIVE LEAD

NOTE: TEST IS MADE TO TEST ALTERNATOR INTERNAL FIELD CIRCUIT. TEST MAY BE PERFORMED WITH ALTERNATOR ON THE VEHICLE OR AS A BENCH TEST

2. LOOSEN ALTERNATOR DRIVE BELT AS IN STEP 2 OF THIS LESSON
3. MARK AND REMOVE LEADS FROM ALTERNATOR
4. TEST BATTERY FOR FULL CHARGE
5. CONNECT JUMPER LEAD BETWEEN ONE ALTERNATOR FIELD TERMINAL AND BATTERY POSITIVE TEST
6. CONNECT AMMETER POSITIVE LEAD TO SECOND FIELD TERMINAL ON ALTERNATOR
7. CONNECT AMMETER NEGATIVE LEAD TO BATTERY NEGATIVE POST
8. SLOWLY ROTATE ATLERNATOR PULLEY BY HAND
9. OBSERVE AMMETER READING

   NOTE: AMMETER READING SHOULD INDICATE FIELD COIL DRAWS BETWEEN 2.5 AND 3.1 AMPERES

   a. LOW AMMETER READING-HIGH RESISTANCE IN ROTOR, SLIP RINGS, OR BRUSHES
   b. HIGH AMMETER READING-SHORTED OR GROUND ROTOR
   c. NO AMMETER READING-OPEN ROTOR OR DEFECTIVE BRUSHES
10. ADJUST DRIVE BELT AS IN STEP 2 OF THIS LESSON
11. CONNECT ALTERNATOR LEADS ACCORDING TO MARKINGS
12. CONNECT BATTERY NEGATIVE LEAD

| | |
|---|---|
| 9. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION.
2. STUDENTS TO USE JOB AND TASK SHEETS.
3. RETEACH IF THE NEED ARISES.
4. ASK QUESTIONS ABOUT STEPS AND KEY POINTS AS STUDENTS PERFORM TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

1. STUDENTS TO BE PLACED ON THEIR OWN TO PERFORM JOB.
2. USE PERFORMANCE TEST.
3. CHECK STUDENTS FOR ACCURACY OF RESULTS.
4. POST RESULTS ON PROGRESS CHART.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

1. EMPHASIZE REMOVAL OF BATTERY NEGATIVE LEAD BEFORE MAKING ANY TEST HOOKUPS.
2. EMPHASIZE THE NEED FOR CAUTION NOT TO DAMAGE ALTERNATOR THROUGH CARELESS PREPARATIONS AND PROCEDURES.
3. EMPHASIZE SAFE WORKING HABITS.
4. EMPHASIZE THE FACT THAT THE BATTERY MUST BE CHECKED FIRST BEFORE MAKING ANY ATTEMPT TO TEST OTHER PARTS OF A CHARGING SYSTEM.
5. EMPHASIZE THE NEED FOR ACCURACY WHEN ADJUSTING DRIVE BELT BECAUSE OF BELT AND PULLEY SMALL CONTACT AREA.
6. REPEAT AREAS TO BE TESTED FROM STAGE II OF THE LESSON.
7. DRILL STUDENTS ON KEY POINTS FOR EACH TEST.

SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 278-281
AUTOMOTIVE ENCYCLOPEDIA, PP. 375-380
AUTO SERVICE AND REPAIR, PP. 22-29 TO 22-41
AUTOMOTIVE MECHANICS, PP. 357-361

THE NEXT LESSON IS: VIII-C-16(S) "PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM"

# JOB SHEET
# IN
# CHARGING SYSTEM

VIII-C-15(J)

**JOB:** TEST A.C. TYPE CHARGING SYSTEM

**MATERIALS:** CLEAN RAGS, SOLVENT

**TOOLS AND EQUIPMENT:** FENDER COVERS, SEAT COVER, DROPLIGHT, BELT TENSION GAUGE, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE, HAND TOOLS, REGULATOR THERMOMETER

**GENERAL INSTRUCTIONS:** BEFORE STARTING THIS JOB READ REFERENCES. STUDY JOB AND TASK SHEETS. TESTS FOR PARTS OF A.C. CHARGING SYSTEM NOT INCLUDED IN THIS JOB ARE THE SAME AS THE D.C. TYPE CHARGING SYSTEM. REFER TO JOB VIII-C-14(J) FOR THESE TASKS. MAKE SURE THAT THE BATTERY NEGATIVE LEAD IS ALWAYS DISCONNECTED BEFORE HOOKING UP OR REMOVING TEST EQUIPMENT. TOO, THE BATTERY MUST BE FULLY CHARGED BEFORE MAKING TESTS. CHECK WITH THE INSTRUCTOR BEFORE STARTING ENGINE OR USING TEST EQUIPMENT.

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-C-15(TS) | CHECK DRIVE BELT TENSION |
| VIII-C-15a(TS) | FIELD CIRCUIT RESISTANCE TEST |
| VIII-C-15b(TS) | CHARGING CIRCUIT RESISTANCE TEST |
| VIII-C-15c(TS) | ALTERNATOR CURRENT OUTPUT TEST |
| VIII-C-15d(TS) | ELECTRONIC VOLTAGE REGULATOR TEST |
| VIII-C-15e(TS) | ROTOR FIELD COIL TEST |
| | CLEAN WORK STATION, AS IN PRECEDING TASKS |

## TASK SHEET VIII-C-15(TS)

TASK: CHECK DRIVE BELT TENSION

JOB: TEST A.C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, BELT TENSION GAUGE, PRY BAR, HAND TOOLS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE VEHICLE | 1. POSITION VEHICLE AS IN PRECEDING TASKS<br>2. RAISE HOOD AND INSTALL FENDER COVERS<br>NOTE: ALTERNATOR DRIVE BELT TENSION IS CRITICAL BECAUSE THE DRIVE PULLEY IS SMALL AND THERE IS LITTLE WRAP AROUND DRIVE BELT ACTION |
| 2. CHECK DRIVE BELT CONDITION | AS IN D.C. GENERATOR BELT INSPECTION |
| 3. ADJUST DRIVE BELT | 1. CHECK MANUFACTURER'S SPECIFICATIONS FOR CORRECT BELT TENSION<br>2. LOOSEN ALTERNATOR SUPPORT BRACKET HINGE BOLTS<br>3. LOOSEN BELT ADJUSTING BRACKET BOLT<br>4. PLACE PRY BAR BETWEEN ENGINE AND HEAVY FRONT SECTION OF ALTERNATOR HOUSING<br>CAUTION: CARE MUST BE TAKEN NOT TO CRUSH THE ALTERNATOR HOUSING WITH THE PRY BAR<br>5. TIGHTEN BELT BY PRYING ALTERNATOR AWAY FROM ENGINE<br>6. HOLD STRAIN ON PRY BAR WITH ONE HAND<br>7. DEPRESS BELT MIDWAY BETWEEN ALTERNATOR PULLEY AND ADJACENT PULLEY WITH OTHER HAND |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: PULL STRAIN ON ALTERNATOR WITH BAR UNTIL THE BELT DEPRESSES APPROXIMATELY ONE-HALF INCH |
| | 8. HOLD STRAIN WITH BAR |
| | 9. TIGHTEN BELT ADJUSTING BRACKET BOLT SECURELY |
| | 10. FIT BELT ADJUSTING GAUGE ON BELT |
| | 11. DEPRESS BELT ADJUSTING GAUGE LEVER |
| | 12. TAKE READING FROM DIAL |
| | 13. COMPARE GAUGE READING WITH SPECIFICATIONS |
| | 14. CONTINUE ADJUSTMENT UNTIL PROPER TENSION IS ACQUIRED ON BELT |
| | 15. REMOVE GAUGE AND BAR |
| | 16. TIGHTEN ALTERNATOR SUPPORT BRACKET HINGE BOLTS SECURELY |

TASK SHEET VIII-C-15a(TS)

TASK: FIELD CIRCUIT RESISTANCE TEST

JOB: TEST A.C. TYPE CHARGING TEST

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HAND TOOLS, FENDER COVERS, SEAT COVERS, DROP LIGHT, VOLTMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP VOLTMETER | 1. REMOVE BATTERY NEGATIVE LEAD CABLE |
| | 2. REMOVE PRIMARY IGNITION WIRE FROM COIL SIDE OF BALLAST RESISTOR |
| | 3. CONNECT VOLTMETER NEGATIVE LEAD TO FIELD TERMINAL OF REGULATOR |
| | 4. CONNECT VOLTMETER POSITIVE LEAD TO POSITIVE POST OF BATTERY |
| | 5. TURN ALL ACCESSORY SWITCHES AND LIGHT SWITCHES OFF |
| | 6. CLOSE ALL VEHICLE DOORS |
| 2. TEST FIELD CIRCUIT | 1. CONNECT BATTERY NEGATIVE LEAD BATTERY POST |
| | 2. TURN ON IGNITION SWITCH<br>NOTE: ENGINE IS NOT TO BE STARTED |
| | 3. TAKE READING FROM VOLTMETER<br>NOTE: VOLTAGE READING IS NOT TO EXCEED .55 VOLT. ANY READING ABOVE .55 VOLT INDICATES HIGH RESISTANCE IN FIELD CIRCUIT BETWEEN REGULATOR FIELD TERMINAL AND BATTERY |
| 3. TEST FIELD CIRCUIT FOR HIGH RESISTANCE POINT | 1. MOVE VOLTMETER NEGATIVE LEAD TO EACH TERMINAL IN THE FIELD CIRCUIT TO THE BATTERY<br>NOTE: IF THERE IS A SUDDEN DROP IN THE VOLTAGE READING THERE IS A LOOSE OR CORRODED TERMINAL BETWEEN TESTED AND THE PRECEDING TERMINALS |

| STEPS | KEY POINTS |
|---|---|
| | 2. MOVE THE VOLTMETER NEGATIVE LEAD BACK TO THE NEXT TERMINAL |
| | 3. GRASP THE TERMINAL LEAD CONNECTION OF THE TERMINAL BEING TESTED |
| | 4. ATTEMPT TO MOVE THE TERMINAL LEAD CONNECTION FROM SIDE TO SIDE |
| | 5. WATCH THE VOLTMETER |
| | NOTE: ANY MOVEMENT OF THE VOLTMETER NEEDLE INDICATES A LOOSE TERMINAL OR IT IS MAKING PARTIAL CONTACT THROUGH THE CORROSION |
| | 6. TIGHTEN OR CLEAN THE TERMINAL |
| 4. REMOVE TEST EQUIPMENT | 1. TURN OFF IGNITION |
| | 2. REMOVE BATTERY NEGATIVE TERMINAL LEAD |
| | 3. DISCONNECT VOLTMETER |
| | 4. CONNECT IGNITION PRIMARY LEAD TO BALLAST RESISTOR TERMINAL |
| | 5. CONNECT BATTERY NEGATIVE LEAD TO NEGATIVE BATTERY POST |

## TASK SHEET

VIII-C-15b(TS)

TASK: CHARGING CIRCUIT RESISTANCE TEST

JOB: TEST A.C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVER, SEAT COVER, DROP LIGHT, HAND TOOLS, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE SWITCH

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TEST EQUIPMENT | 1. DISCONNECT BATTERY NEGATIVE TERMINAL LEAD |
| | 2. REMOVE "BAT" LEAD FROM ALTERNATOR OUTPUT TERMINAL |
| | 3. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND DISCONNECTED "BAT" LEAD |
| | 4. CONNECT VOLTMETER POSITIVE LEAD TO "BAT" LEAD WITH VOLTMETER LEAD |
| | 5. CONNECT VOLTMETER NEGATIVE LEAD TO BATTERY POSITIVE POST |
| | 6. DISCONNECT FIELD LEAD FROM ALTERNATOR TO VOLTAGE REGULATOR AT ALTERNATOR |
| | 7. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL WHERE THE LEAD HAS BEEN REMOVED |
| | 8. CONNECT OPPOSITE END OF JUMPER LEAD TO A GOOD GROUND |
| | 9. CONNECT TACHOMETER BETWEEN DISTRIBUTOR PRIMARY IGNITION LEAD AND A GOOD GROUND |
| | 10. TURN CARBON PILE SWITCH TO OFF POSITION |
| | 11. CONNECT CARBON PILE BETWEEN BATTERY TERMINALS |
| 2. PERFORM CHARGING CIRCUIT RESISTANCE TEST | 1. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| | 2. START ENGINE |
| | 3. RUN ENGINE AT IDLE SPEED |
| | 4. ADJUST ENGINE RPM AND CARBON PILE |

| STEPS | KEY POINTS |
|---|---|
| | SWITCH TO MAINTAIN 20 AMPERE FLOW IN CHARGING SYSTEM |
| | 5. OBSERVE VOLTMETER |
| | NOTE: VOLTMETER READING IS NOT TO EXCEED .7 VOLT. IF VOLTMETER READING IS ABOVE .7 VOLT INSPECT, CLEAN, AND TIGHTEN ALL CHARGING CIRCUIT CONNECTIONS |
| | 6. PERFORM VOLTAGE DROP TEST AT EACH TERMINAL TO LOCATE TERMINAL WITH EXCESSIVE RESISTANCE |
| 3. REMOVE TEST EQUIPMENT | 1. RESET ENGINE IDLE RPM ACCORDING TO SPECIFICATIONS |
| | 2. TURN OFF CARBON PILE SWITCH |
| | 3. STOP ENGINE |
| | 4. DISCONNECT BATTERY NEGATIVE LEAD |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. CONNECT FIELD LEAD TO ALTERNATOR FIELD TERMINAL |
| | 7. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

TASK SHEET VIII-C-15c(TS)

TASK: ALTERNATOR CURRENT OUTPUT TEST

JOB: TEST A. C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, AMMETER, VOLTMETER, JUMPER LEAD, TACHOMETER, CARBON PILE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| | NOTE: TEST IS PERFORMED TO DETERMINE WHETHER OR NOT ALTERNATOR WILL DELIVER ITS RATED CURRENT OUTPUT |
| 1. HOOK UP EQUIPMENT | 1. DISCONNECT BATTERY NEGATIVE LEAD<br>2. REMOVE "BAT" LEAD AT ALTERNATOR OUTPUT TERMINAL<br>3. CONNECT AMMETER BETWEEN ALTERNATOR "BAT" TERMINAL AND DISCONNECTED "BAT" LEAD<br>4. CONNECT VOLTMETER POSITIVE LEAD TO ALTERNATOR "BAT" TERMINAL<br>5. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND<br>6. REMOVE ALTERNATOR TO VOLTAGE REGULATOR FIELD LEAD AT ALTERNATOR<br>7. CONNECT JUMPER LEAD TO ALTERNATOR FIELD TERMINAL WHERE LEAD HAS BEEN REMOVED<br>8. CONNECT SECOND END OF JUMPER TO GOOD GROUND<br>9. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY IGNITION LEAD AND GOOD GROUND<br>10. TURN CARBON PILE SWITCH TO OFF<br>11. CONNECT CARBON PILE BETWEEN BATTERY POSTS |
| 2. PERFORM ALTERNATOR CURRENT OUTPUT TEST | 1. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

| STEPS | KEY POINTS |
|---|---|
| | 2. START ENGINE AND RUN AT IDLE RPM |
| | 3. GRADUALLY INCREASE ENGINE SPEED TO 1250 RPM |
| | 4. ADJUST CARBON PILE UNTIL VOLTMETER READING IS 15 VOLTS |
| | CAUTION: VOLTMETER IS NOT TO REACH A READING ABOVE 16 VOLTS |
| | 5. CHECK MANUFACTURER'S SPECIFICATIONS FOR ALTERNATOR OUTPUT LIMITS |
| | NOTE: IF AMMETER READING IS LESS THAN SPECIFIED LIMITS ALTERNATOR SHOULD BE REMOVED FROM THE VEHICLE AND BENCH TESTED |
| 3. REMOVE TEST EQUIPMENT | 1. TURN OFF CARBON PILE SWITCH |
| | 2. ADJUST ENGINE IDLE RPM |
| | 3. STOP ENGINE |
| | 4. REMOVE BATTERY NEGATIVE LEAD |
| | 5. REMOVE TEST EQUIPMENT |
| | 6. CONNECT "BAT" LEAD TO ALTERNATOR "BAT" TERMINAL |
| | 7. CONNECT FIELD LEAD TO ALTERNATOR FIELD TERMINAL |
| | 8. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

## TASK SHEET VIII-C-15d(TS)

TASK: ELECTRONIC VOLTAGE REGULATOR TEST

JOB: TEST A.C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, VOLTMETER, TACHOMETER, REGULATOR, THERMOMETER

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. HOOK UP TEST EQUIPMENT | 1. REMOVE BATTERY TERMINAL LEADS |
| | 2. THOROUGHLY CLEAN BATTERY POSTS AND TERMINAL CONNECTORS |
| | 3. CONNECT VOLTMETER POSITIVE LEAD TO IGNITION NUMBER ONE TERMINAL AT BALLAST RESISTOR |
| | 4. CONNECT VOLTMETER NEGATIVE LEAD TO GOOD GROUND |
| | 5. CONNECT TACHOMETER TO DISTRIBUTOR PRIMARY IGNITION LEAD AND GOOD GROUND |
| | 6. CONNECT REGULATOR THERMOMETER TO REGULATOR |
| 2. PERFORM ELECTRONIC VOLTAGE REGULATOR TEST | 1. CONNECT BATTERY POSITIVE LEAD TO BATTERY POSITIVE POST |
| | 2. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| | 3. START ENGINE |
| | 4. SET ENGINE SPEED AT 1250 RPM |
| | NOTE: NO LIGHTS OR ACCESSORIES ARE TO BE ON AND THE VEHICLE DOORS ARE TO BE CLOSED |
| | 5. CHECK MANUFACTURER'S SPECIFICATIONS FOR AMBIENT AIR TEMPERATURE AND CORRESPONDING VOLTAGE READING LIMITS |
| | 6. ALLOW REGULATOR TO WARM UP TO OPERATING TEMPERATURE |
| | 7. TAKE READING FROM VOLTMETER |
| | 8. TAKE READING FROM REGULATOR THERMOMETER |

| STEPS | KEY POINTS |
|---|---|
| | 9. COMPARE AMBIENT AIR TEMPERATURE TO VOLTMETER READING |
| A. VOLTAGE READING BELOW SPECIFICATIONS TEST | 1. STOP ENGINE<br>2. PERFORM REGULATOR GROUND TEST, USE TASK SHEET<br>3. REMOVE BATTERY NEGATIVE LEAD<br>4. DISCONNECT REGULATOR CONNECTOR<br>5. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST<br>6. TURN ON IGNITION SWITCH<br>NOTE: ENGINE IS NOT TO BE STARTED<br>7. CHECK FOR BATTERY VOLTAGE IN WIRING HARNESS<br>a. USE VOLTMETER<br>b. PROBE BOTH WIRING HARNESS TERMINALS<br>NOTE: NO VOLTAGE AT EITHER LEAD<br>a. PROBLEM IS IN VEHICLE WIRING "OR"<br>b. PROBLEM IS IN ALTERNATOR FIELD CIRCUIT<br>NOTE: VOLTAGE PRESENT AT BOTH LEADS, REPLACE REGULATOR<br>8. DISCONNECT BATTERY NEGATIVE LEAD<br>9. CONNECT REGULATOR CONNECTOR TO REGULATOR<br>10. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| B. VOLTAGE READING HIGHER THAN SPECIFICATIONS TEST | 1. PERFORM REGULATOR GROUND TEST, USE TASK SHEET<br>2. PERFORM CHARGING SYSTEM GROUND TEST, USE TASK SHEET<br>NOTE: SYSTEM AND REGULATOR HAVE PROPER GROUND, PROBLEM IS INTERNAL AND REGULATOR MUST BE REPLACED<br>NOTE: ALL OTHER REGULATOR TESTS ARE MADE THE SAME AS THE D.C. CHARGING SYSTEM USE JOB SHEET |

| STEPS | KEY POINTS |
|---|---|
| 3. REMOVE TEST EQUIPMENT | 1. START ENGINE<br>2. ADJUST ENGINE SPEED TO IDLE RPM<br>3. STOP ENGINE<br>4. DISCONNECT BATTERY NEGATIVE LEAD<br>5. REMOVE TEST EQUIPMENT<br>6. CONNECT BATTERY NEGATIVE LEAD TO BATTERY NEGATIVE POST |

## TASK SHEET VIII-C-15e(TS)

TASK: ROTOR FIELD COIL TEST

JOB: TEST A.C. TYPE CHARGING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FENDER COVERS, SEAT COVER, DROP LIGHT, HAND TOOLS, BATTERY TESTER, AMMETER, JUMPER LEAD, BELT ADJUSTING GAUGE

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. TEST BATTERY | 1. FOR FULL CHARGE |
| | 2. REMOVE BATTERY NEGATIVE LEAD |
| | 3. REMOVE BATTERY POSITIVE LEAD |
| | 4. PERFORM BATTERY CHARGE TEST, USE TASK SHEET |
| | 5. CHARGE BATTERY IF NECESSARY |
| 2. HOOK UP TEST EQUIPMENT | 1. LOOSEN ALTERNATOR DRIVE BELT, USE TASK SHEET |
| | 2. MARK AND REMOVE LEADS FROM ALTERNATOR |
| | 3. CONNECT JUMPER LEAD BETWEEN ONE ALTERNATOR FIELD TERMINAL AND BATTERY POSITIVE POST |
| | 4. CONNECT AMMETER POSITIVE LEAD TO ALTERNATOR SECOND FIELD TERMINAL |
| | 5. CONNECT AMMETER NEGATIVE LEAD TO BATTERY NEGATIVE POST |
| 3. PERFORM ROTOR FIELD COIL DRAW TEST | 1. SLOWLY ROTATE ALTERNATOR PULLEY BY HAND |
| | 2. OBSERVE AMMETER READING |
| | NOTE: AMMETER READING SHOULD INDICATE FIELD COIL DRAW BETWEEN 2.5 AND 3.1 AMPERES<br>LOW AMMETER READING - THERE IS HIGH RESISTANCE IN ROTOR, SLIP RINGS, OR BRUSHES<br>HIGH AMMETER READING - THE ROTOR IS SHORTED OR GROUNDED<br>NO AMMETER READING - THERE IS AN OPEN IN THE ROTOR OR THE BRUSHES ARE DEFECTIVE |

| STEPS | KEY POINTS |
|---|---|
| 4. REMOVE TEST EQUIPMENT | 1. REMOVE JUMPER LEAD AND AMMETER<br>2. CONNECT ALL ALTERNATOR LEADS TO PROPER TERMINALS AS MARKED<br>3. ADJUST ALTERNATOR DRIVE BELT, USE TASK SHEET<br>4. CONNECT BATTERY LEADS, POSITIVE FIRST AND NEGATIVE LAST |
| 5. CLEAN WORK STATION | AS IN PRECEDING TASKS |

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-16(S)

| | |
|---|---|
| TASK: | PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM |
| AIM: | 1. THE STUDENT WILL BE ABLE TO PERFORM THE NECESSARY STEPS REQUIRED TO PRESSURE TEST THE ENGINE LIQUID COOLING SYSTEM<br>2. THE STUDENT WILL BE ABLE TO DIAGNOSE ENGINE LIQUID COOLING SYSTEM MALFUNCTIONS<br>3. THE STUDENT WILL BE ABLE TO SERVICE AND REPAIR THE ENGINE LIQUID COOLING SYSTEM |
| TOOLS AND EQUIPMENT: | COOLING SYSTEM PRESSURE TESTER |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | MANUFACTURER'S SPECIFICATIONS, TRANSPARENCIES, I. ED. II 7T, FIGS. 52-53 |
| REFERENCES: | AUTOMECHANICS, PP. 71-72<br>MOTOR SERVICE'S AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113<br>AUTO SERVICE AND REPAIR, CH. 19<br>AUTOMOTIVE MECHANICS, CH. 12, P. 332 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | MUST HAVE SUCCESSFULLY COMPLETED ALL THE TASKS AND EXHIBITED AN ABILITY TO MAKE JUDGEMENTS AND DECISIONS FOR ALL MATERIAL IN MAJOR BLOCK VIII, MINOR BLOCK C |
| CHECKING STANDARDS: | 1. SELECT PROPER TOOLS AND EQUIPMENT.<br>2. MAINTAIN CRAFTSMANLIKE WORK.<br>3. APPRECIATION FOR TOOLS, EQUIPMENT, AND AUTOMOBILE.<br>4. FOLLOW STANDARD PROCEDURES AS SET FORTH BY THE INSTRUCTOR. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

AUTOMOBILE ENGINES ARE COOLED EITHER BY A CLOSED LIQUID COOLING SYSTEM OR AIR COOLED. THE LIQUID COOLING SYSTEM IS THE MOST POPULAR AND REQUIRES MORE MAINTENANCE. BEING ABLE TO SERVICE, REPAIR, MAINTAIN, AND CHECK AN AUTOMOBILE LIQUID COOLING SYSTEM IS A MUST FOR A MECHANIC. THE TOTAL GOOD OPERATION OF AN AUTOMOBILE ENGINE IS DEPENDENT UPON THE COOLING SYSTEM FUNCTIONING PROPERLY. THIS LESSON DEALS WITH THE PRESSURE CHECK OF A LIQUID COOLING SYSTEM, THE DIAGNOSIS OF PROBLEMS FOUND BY THIS TEST, AND POSSIBLE REPAIRS NEEDED TO CORRECT THE PROBLEM.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | FOLLOW PROCEDURE AS SET FORTH IN PRECEDING LESSONS |
| 2. PRIMARY INSPECTION OF COOLING SYSTEM | 1. WHILE ENGINE IS COLD<br>2. CAUTION:<br>a. EXPLAIN HAZARD OF PRESSURE IN COOLING SYSTEM<br>b. EXPLAIN PROCEDURE FOR WORKING WITH HOT ENGINE<br>3. HOSES<br>a. CRACKS<br>b. LEAKS<br>c. SOFT OR WEAR SPOTS<br>d. HARDENING<br>4. REMOVE RADIATOR CAP<br>a. CHECK SEALING GASKET<br>b. INSPECT VACUUM VALVE<br>5. RADIATOR<br>a. RUST AND CORROSION<br>b. DYE STAINS<br>c. LEAKS<br>d. OIL IN COOLANT<br>e. EXPLAIN SOFT THIN METAL OF RADIATOR IS SUBJECT TO PUNCTURE<br>6. SURGE TANK<br>a. OVERALL CONDITION<br>b. OIL IN COOLANT<br>7. WATER PUMP<br>a. LEAKING GASKET<br>b. LEAKING SEAL<br>c. WORN BUSHING<br>8. BELT<br>a. CORRECT TENSION<br>b. WORN<br>c. FRAYED<br>d. CRACKED<br>e. TOO DEEP OR SHALLOW IN V PULLEY |
| 3. PRESSURE TEST RADIATOR CAP | 1. REMOVE CAP<br>2. CLEAN POSSIBLE OIL, RUST, CORROSION<br>3. CONNECT CAP TO TESTER (EXPLAIN) |

4. CHECK SPECIFICATIONS FOR CAP
5. PUMP TESTER AND WATCH GAUGE
6. CHECK THAT VALVE RELEASES AT SPECIFIED PRESSURE
7. DOES CAP VALVE LEAK? DOES CAP VALVE RETAIN TOO MUCH PRESSURE?

4. PRESSURE COOLING SYSTEM
SHOW: TRANSPARENCIES
FIGS. 52-53

1. CLEAN RADIATOR FILLER NECK
   a. USE COARSE BRISTLE BRUSH
   b. USE CAUTION KEEP TRASH OUT OF RADIATOR
   c. USE CLEAN RAG WIPE NECK CLEAN
2. CHECK COOLANT LEVEL. COOLANT MUST BE EVEN WITH FILL LINE. IF LOW ADD COOLANT. IF TOO HIGH REMOVE COOLANT
3. INSTALL PRESSURE TESTER ON RADIATOR NECK (EXPLAIN)
4. CHECK SPECIFICATIONS FOR VEHICLE COOLING SYSTEM PRESSURE RATING
5. PUMP PRESSURE TESTER TO VEHICLE SPECIFIED RATING
6. OBSERVE GAUGE
   a. IF PRESSURE LEAKS DOWN
      (1) RADIATOR
      (2) ENGINE BLOCK
         (a) CRACKS
         (b) FREEZE PLUGS
      (3) WATER PUMP
      (4) HOSES
         (a) UPPER AND LOWER
         (b) BY-PASS
      (5) HEATER
         (a) HOSES
         (b) CORE
   b. IF NO PRESSURE LEAK OCCURS CONTINUE CHECK

5. CHECK FOR INTERNAL LEAKS

1. PRESSURE TESTER GAUGE REMAINS CONNECTED TO SYSTEM
2. START ENGINE
3. IDLE ENGINE UNTIL OPERATING TEMPERATURE IS REACHED
4. APPLY 7 PSI WITH TESTER GAUGE
5. INCREASE ENGINE RPM TO 2000

NOTE: FLUCTUATING GAUGE NEEDLE

INDICATES LEAKING HEAD GASKET

NOTE: TO CHECK "V" TYPE ENGINE

- a. DISCONNECT SPARK PLUG WIRES FROM ONE BANK
- b. ONLY FIRING BANK WILL INDICATE GASKET LEAK

6. TEST COOLANT

1. START ENGINE
2. IDLE ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED
3. STOP ENGINE
4. CAUTION: COOLANT WILL BE HOT, PRESSURE WILL HAVE BUILT UP IN COOLING SYSTEM
5. REMOVE CAP

   NOTE: BACK CAP OFF TO THE FIRST NOTCH. ALLOW THE PRESSURE TO RELEASE. AFTER PRESSURE HAS BEEN RELEASED REMOVE CAP
6. INSERT OPEN END OF HYDROMETER TUBE INTO RADIATOR NECK AND INTO COOLANT
7. SQUEEZE HYDROMETER BULB AND RELEASE, DRAWING COOLANT INTO HYDROMETER
   - a. SQUIRT COOLANT BACK INTO RADIATOR
   - b. REPEAT THIS PROCEDURE UNTIL HYDROMETER TEMPERATURE IS EQUAL TO COOLANT TEMPERATURE
8. DRAW COOLANT INTO HYDROMETER ACCORDING TO HYDROMETER MANUFACTURER'S SPECIFICATIONS
9. TAKE HYDROMETER READING
10. COMPARE THE READING TO COOLANT CHART AND DETERMINE PROTECTIVE TEMPERATURE AND COOLANT TO WATER RATIO

7. PERFORM HOUSEKEEPING CHORES

1. CLEAN VEHICLE
2. REMOVE VEHICLE FROM STALL
3. CLEAN TOOLS AND EQUIPMENT
4. RETURN TOOLS AND EQUIPMENT TO STORAGE
5. CLEAN WORK AREAS

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO GIVE BACK STEPS OF TASK.
2. CHECK STUDENTS FOR COMPREHENSION OF KEY POINTS.
3. CHECK STUDENTS FOR POINTS OF SAFETY.
4. STUDENTS TO PRACTICE ON TASKS.

   USE JOB SHEET, VIII-C-16(J)

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## IV. VERIFICATION AND/OR EVALUATION (CHECK OF STUDENTS' ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

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## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP FROM STAGE II AND EMPHASIZE PERTINENT POINTS.
2. PLACE EMPHASIS ON SAFETY.
3. STRESS POINTS CONCERNING CARE OF THE CUSTOMER'S VEHICLE.
4. REEMPHASIZE HIGHLIGHTS OF KEY POINTS.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, CH. 2
AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113
AUTO SERVICE AND REPAIR, CH. 19
AUTOMOTIVE MECHANICS, CH. 19, P. 332

THE NEXT LESSON IS: VIII-C-17(S) "SERVICE FUEL TANK FOR 1975 FORD AND MERCURY"

## JOB SHEET

VIII-C-16(J)

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**MATERIALS:** CLEAN RAGS, COOLANT

**TOOLS AND EQUIPMENT:** PRESSURE GAUGE, HYDROMETER

**GENERAL INSTRUCTIONS:** BEFORE BEGINNING THE JOB, READ ALL NECESSARY RELATED INFORMATION:

AUTOMECHANICS, PP. 71-72
AUTOMOTIVE ENCYCLOPEDIA, PP. 99-113
AUTO SERVICE AND REPAIR, CH. 19
AUTOMOTIVE MECHANICS, CH. 12, P. 332

READ DIRECTIONS FOR HYDROMETER USE AS SPECIFIED BY MANUFACTURER. CHECK OUT PRESSURE GAUGE AND HYDROMETER CHECK FOR PROPER PERFORMANCE.

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-C-16(TS) | PREPARE VEHICLE |
| VIII-C-16a(TS) | INSPECT COOLING SYSTEM |
| VIII-C-16b(TS) | PRESSURE TEST RADIATOR CAP |
| VIII-C-16c(TS) | PRESSURE TEST LIQUID COOLING SYSTEM |
| VIII-C-16d(TS) | TEST COOLANT |

**CHECK POINT:** BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK.

CLEAN WORK STATION AS IN PRECEDING TASK

## TASK SHEET VIII-C-16(TS)

**TASK:** PREPARE VEHICLE

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BATTERY PLIERS, TERMINAL PULLER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. START ENGINE<br>2. DRIVE THE VEHICLE INTO CENTER OF STALL<br>3. ALIGN VEHICLE PROPERLY IN STALL<br>a. USE ASSISTANT<br>b. HAVE ASSISTANT STAND CLEAR OF VEHICLE<br>4. PUT VEHICLE IN PARK<br>5. SET FOOT OR HAND BRAKE |
| 2. LET VEHICLE COOL | 1. LET ENGINE COOL UNTIL IT REACHES TOUCHABLE TEMPERATURE<br>a. HOT ENGINE CAN BURN HANDS<br>b. HOT RADIATOR COOLANT CAN BURN HANDS<br>2. VISUALLY INSPECT COOLING SYSTEM FOR LEAKS |
| 3. PERFORM VEHICLE SAFETY | 1. DISCONNECT NEGATIVE BATTERY CABLE<br>2. DISCONNECT POSITIVE BATTERY CABLE<br>3. REMOVE KEYS FROM IGNITION |

**TASK SHEET** VIII-C-16a(TS)

TASK: INSPECT COOLING SYSTEM

JOB: PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BELT TENSION GAUGE OR STRAIGHT EDGE, SCREW DRIVER, HOSE CLAMP PLIERS, RULER, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK HOSES | 1. NOTE: THIS INSPECTION IS TO BE MADE WHILE THE ENGINE IS COLD<br>2. CRACKS<br>a. RADIATOR, HEATER, AND BY-PASS<br>b. PRESS HOSES AT SEVERAL POINTS BY HAND<br>c. CRACKS WILL OPEN UP<br>3. LEAKS<br>a. HOLE IN HOSE<br>b. AT CLAMPS<br>c. DISCOLORATION ON HOSE, RADIATOR, OR BLOCK WILL INDICATE LEAK<br>4. SOFT OR WEAK SPOTS<br>a. BULGING SPOTS IN HOSE<br>b. PRESS HOSE AT SEVERAL SPOTS BY HAND, GOOD HOSE WILL FEEL PLIABLE AND RETURN TO MATERIAL SHAPE EASILY<br>5. HARDENING<br>a. RESISTANT TO PRESSURE<br>b. WILL PROBABLY CRACK UNDER EXCESS PRESSURE<br>c. IS NOT PLIABLE |
| 2. CHECK RADIATOR CAP | 1. REMOVE RADIATOR CAP<br>a. CHECK FOR PROPER REMOVAL<br>(1) FIRST NOTCH<br>(2) FINAL REMOVAL<br>b. CORROSION<br>c. SEALING GASKET IN GOOD SHAPE<br>d. THE VACUUM VALVE OPERATES FREELY<br>2. REPLACE RADIATOR CAP, TIGHTEN |

| STEPS | KEY POINTS |
|---|---|
|  | DOWN FIRMLY |
| 3. CHECK RADIATOR | 1. REMOVE CAP<br>2. RUST AND CORROSION IN TANK<br>3. DYE STAINS ON OUTSIDE TANKS AND CORE<br>4. LEAKS CORE AND TANKS<br>5. OIL IN COOLANT<br>6. CHECK SURGE TANK |
| 4. CHECK WATER PUMP | 1. LEAKS<br>a. GASKET<br>b. SEAL<br>2. WORN BEARING OR BUSHING<br>a. GRASP BLADE<br>b. WORK BLADE FORWARD AND BACK. EXCESS PLAY INDICATES WORN BEARING, BUSHING, OR LOOSE FAN |
| 5. CHECK BELT | 1. CORRECT TENSION, CHECK SPECIFICATIONS<br>2. WORN<br>a. TOO DEEP IN GROOVE<br>b. FRAYED<br>c. CRACKED |

## TASK SHEET

VIII-C-16b(TS)

**TASK:** PRESSURE TEST RADIATOR CAP

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** PRESSURE GAUGE, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN CAP | 1. REMOVE CAP |
| | 2. WIRE WITH CLEAN RAG<br>a. OIL<br>b. RUST<br>c. CORROSION |
| | 3. BRUSH WITH MODERATELY FIRM BRISTLE BRUSH |
| 2. CONNECT CAP TO TESTER | 1. INVERT TESTER WITH NECK UP |
| | 2. PLACE CAP ON NECK BOTTOM SIDE UP CAP DOWN |
| | 3. TWIST CAP TO RIGHT AND TIGHTEN AS IF ON RADIATOR |
| 3. PRESSURIZE CAP | 1. TURN GAUGE RIGHT SIDE UP |
| | 2. PUMP BULB OF TESTER TO CAP SPECIFICATIONS WATCH GAUGE |
| | 3. READ DIAL INDICATOR |
| | 4. DOES VALVE RELEASE AT SPECIFIED PRESSURE? |
| | 5. DOES VALVE LEAK? |
| | 6. DOES VALVE RETAIN TOO MUCH PRESSURE? |

## TASK SHEET

VIII-C-16c(TS)

**TASK:** PRESSURE TEST COOLING SYSTEM

**JOB:** PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** PRESSURE GAUGE, CLEAN RAGS, BRUSH

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CLEAN NECK OF RADIATOR | 1. REMOVE CAP |
| | 2. USE COARSE BRISTLE BRUSH |
| | a. BRUSH OUTSIDE OF NECK |
| | b. USE CAUTION TO KEEP TRASH OUT OF RADIATOR |
| | 3. USE CLEAN RAG |
| | a. WIPE INSIDE OF NECK CLEAN OF OIL, RUST, CORROSION |
| | b. WIPE NECK SEAT AND OUTSIDE CLEAN |
| 2. CHECK COOLANT LEVEL | 1. CHECK BY SIGHT |
| | 2. LOOK INTO TOP TANK OR FILLER TANK |
| | 3. COOLANT MUST BE EVEN WITH FILL LINE |
| | a. IF LOW ADD COOLANT TO FILL LINE |
| | b. IF OVER FILL LINE REMOVE COOLANT WITH SUCTION BULB |
| 3. INSTALL PRESSURE GAUGE ON NECK | 1. PLACE OVER NECK |
| | 2. TURN TO RIGHT |
| | 3. TIGHTEN UNTIL SEATED PROPERLY |
| 4. MAKE PRESSURE TEST | 1. CHECK SPECIFICATIONS FOR VEHICLE COOLING SYSTEM PRESSURE RATING |
| | 2. OBSERVE GAUGE |
| | 3. PUMP PRESSURE TESTER TO VEHICLE SPECIFICATIONS |
| | 4. OBSERVE GAUGE |
| | a. IF PRESSURE LEAKS DOWN |
| | (1) RADIATOR LEAKS |
| | (2) ENGINE BLOCK |
| | (a) CRACKED |
| | (b) BAD FREEZE PLUGS |

| STEPS | KEY POINTS |
|---|---|
| | (c) BAD GASKET |
| | (3) WATER PUMP |
| | (a) BAD SEAL |
| | (b) BAD GASKET |
| | (4) HOSES |
| | (a) CRACKED |
| | (b) BAD CONNECTIONS |
| | (c) HOLES |
| | (5) HEATER |
| | (a) CORE LEAKS |
| | (b) HOLES OR CONNECTIONS LEAK |
| | (c) VALVE LEAKS |
| | 5. IF NO PRESSURE LEAK CONTINUE CHECK |
| 5. CHECK FOR INTERNAL LEAK | 1. PRESSURE TESTER GAUGE REMAINS CONNECTED TO SYSTEM |
| | 2. START ENGINE |
| | 3. IDLE ENGINE UNTIL OPERATING TEMPERATURE IS REACHED |
| | 4. APPLY 7 PSI TO SYSTEM WITH PRESSURE TESTER |
| | 5. INCREASE ENGINE RPM TO 2000<br>NOTE: FLUCTUATING GAUGE NEEDLE INDICATES LEAKING HEAD GASKET |
| | 6. "V" TYPE ENGINE CHECK |
| | a. DISCONNECT SPARK PLUG WIRES FROM ONE BANK |
| | b. ONLY FIRING BANK WILL INDICATE GASKET LEAK |

## TASK SHEET VIII-C-16d(TS)

TASK: TEST COOLANT

JOB: PRESSURE CHECK ENGINE LIQUID COOLING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: HYDROMETER, COOLANT, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE ENGINE | 1. START ENGINE<br>2. IDLE ENGINE<br>3. COOLANT IS TO BE AT OPERATING TEMPERATURE<br>4. STOP ENGINE |
| 2. REMOVE RADIATOR CAP | 1. RAISE HOOD<br>2. CAUTION:<br>a. PRESSURE HAS BUILT UP IN SYSTEM IF CAP IS REMOVED SUDDENLY COOLANT WILL BLOW OUT OF RADIATOR<br>b. COOLANT IS VERY HOT AND SEVERE BURNS CAN BE THE RESULT<br>3. BACK RADIATOR CAP OFF TO FIRST NOTCH<br>4. ALLOW PRESSURE TO RELEASE<br>5. AFTER PRESSURE IS COMPLETELY RELEASED TAKE RADIATOR CAP OFF |
| 3. CHECK COOLANT FAHRENHEIT DEGREES | 1. INSERT OPEN END OF HYRDOMETER TUBE INTO RADIATOR NECK AND BELOW COOLANT LEVEL<br>2. SQUEEZE HYDROMETER BULB AND RELEASE<br>a. DRAW COOLANT INTO HYDROMETER BARREL<br>b. SQUEEZE BULB FORCING COOLANT BACK INTO RADIATOR<br>c. CONTINUE TO DRAW COOLANT IN AND OUT UNTIL THE HYDROMETER THERMOMETER IS SAME TEMPERATURE AS COOLANT<br>3. DRAW COOLANT INTO HYDROMETER |

| STEPS | KEY POINTS |
|---|---|
|  | ACCORDING TO MANUFACTURER'S DIRECTIONS<br>a. TAKE HYDROMETER READING<br>b. TAKE TEMPERATURE READING FROM HYDROMETER THERMOMETER<br>4. COMPARE READINGS TO TYPE COOLANT CHART<br>5. DETERMINE PROTECTIVE TEMPERATURE OF COOLANT<br>6. RECORD FINDINGS<br>7. SQUEEZE COOLANT BACK INTO RADIATOR AND REMOVE HYDROMETER FROM RADIATOR<br>8. REPLACE RADIATOR CAP<br>9. CLEAN HYDROMETER ACCORDING TO MANUFACTURER'S DIRECTIONS<br>10. CLOSE HOOD |

VIII-C-21(I)

# INSTRUCTOR'S PLAN
# INFORMATIONAL LESSON

SUBJECT: FUEL TANK

AIM: THE STUDENT WILL BE ABLE TO DESCRIBE FUEL TANK COMPONENTS AND THEIR FUNCTION.

TEACHING AIDS:
TRANSPARENCIES I. ED. II 7T, FIGS. 556-559
VARIOUS TYPES FUEL FILTERS
CHALKBOARD

MATERIALS: CHALK

REFERENCES:
AUTOMOTIVE MECHANICS, CROUSE, CHS. 9 AND 20
AUTOMECHANICS, GLENN, CH. 6
AUTO SERVICE AND REPAIR, STOCKEL, CH. 20
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 255-270

PREREQUISITE EXPERIENCE OF THE LEARNER: THE STUDENT SHOULD HAVE READ THE REFERENCES FOR THIS LESSON.

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WE HAVE COME A LONG WAY FROM THE TIME WHEN A CAR ENGINE WAS GRAVITY FED FROM THE FUEL TANK MOUNTED HIGHER THAN ITSELF. FUEL SYSTEMS ON MODERN VEHICLES INCLUDE THE CARBURETOR, FUEL PUMP, CONNECTING HOSES AND TUBING, AND THE FUEL TANK WITH ITS FILTERS AND GAUGES. TODAY WE WILL LEARN ABOUT THE COMPONENTS THAT MAKE UP THE FUEL RESERVOIR MORE COMMONLY KNOWN AS A "GAS TANK."

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS TEACHING POINTS | THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. TYPES OF FUEL TANKS | 1. CONSTRUCTED OF HIGH GRADE SHEET STEEL<br>2. METAL THICKNESS DEPENDS ON:<br>a. VOLUME CONTAINED - LARGER TANKS REQUIRE MORE STRENGTH TO SUSTAIN EXTRA WEIGHT<br>b. TYPE FUEL - BUTANE AND PROPANE PRODUCE MUCH PRESSURE AND NEED VERY STRONG TANKS<br>3. VOLUME USUALLY RELATES TO SIZE OF VEHICLE |

4. SOME TANKS HAVE FUEL PUMP INSIDE

B. LOCATION AND SUPPORTS

1. TANK USUALLY LOCATED IN REAR OF VEHICLE
2. SPACE PROVIDED IN CAR FRAME
3. FRAME PROTECTS FUEL TANK IN COLLISIONS
4. STEEL STRAPS SUPPORT TANK
    a. FIT IN GROOVES OF TANK
    b. BOLT AND NUT END PROVIDE FOR REMOVAL
5. INSULATION BETWEEN TANK AND BODY ADDS PROTECTION AND REDUCES NOISE
6. INTERNAL BAFFLES INHIBIT MOVEMENT OF FUEL

SHOW: TRANSPARENCIES
FIGS. 556-559

C. VENTILATION SYSTEMS

1. OLDER DESIGNS VENTED TO ATMOSPHERE
2. WAS CONTRIBUTING FACTOR TO SMOG FORMATION
3. SINCE 1970 CARS EQUIPPED WITH VVR SYSTEM
    a. VEHICLE VAPOR RECOVERY SYSTEM
    b. VENT PIPE CONNECTED TO VAPOR TRAP
    c. TRAP CONDENSES VAPOR AND RETURNS IT TO FUEL TANK
    d. MAY HAVE VAPOR RETURN LINE FUEL PUMP ESPECIALLY IF CAR IS AIR CONDITIONED

D. FUEL FILTER

1. KEEPS FOREIGN MATERIAL OUT OF FUEL PUMP AND CARBURETOR
2. SOME ARE LOCATED IN FUEL PUMP
3. FUEL TANK MAY HAVE INTERNAL FILTER
4. MOST HAVE FILTER ELEMENT IN GAS LINE
5. THOSE COMPOSED OF PAPER MUST BE CHANGED
6. OTHERS MADE OF SCREEN, CERAMIC, AND POROUS BRONZE MAY BE CLEANED AND REUSED

E. GAUGE UNITS

1. BALANCING COIL AND THERMOSTATIC TYPES OF FUEL GAUGES

2. BOTH HAVE A DASH UNIT AND TANK UNIT
3. EACH OPERATES ON BATTERY VOLTAGE THROUGH IGNITION SWITCH

1. THERMOSTATIC TYPE

SHOW: TRANSPARENCY FIG. 558

1. THERMOSTAT BLADE ENCLOSED IN HEATING COIL FOR EACH UNIT
2. HEATING COILS WIRED IN SERIES
3. FLOAT IN TANK UNIT OPERATES A CAM
4. CAM TURNS, CAUSING BEND IN THERMOSTAT BLADE
5. CURRENT FLOW HEATS COIL, CAUSING MORE BEND
6. EXCESSIVE BENDING SEPARATES CONTACTS, STOPPING CURRENT
7. THERMOSTAT BLADE COOLS, CLOSING POINTS AND PROCESS REPEATED
8. AMOUNT OF BEND OF TANK THERMOSTAT IS RELAYED TO DASH UNIT THERMOSTAT BLADE
9. DASH THERMOSTAT BENDS ACCORDINGLY AND OPERATES POINTER LINKAGE
10. TANK FULL - MORE CURRENT REQUIRED TO BREAK CONTACT, CAUSING MORE HEATING AND BENDING SO POINTER MOVES TO FULL SIDE OF GAUGE
11. TANK EMPTY - CAM IMPOSES LITTLE BEND SO SMALL AMOUNT OF CURRENT BREAKS CONTACTS AND DASH UNIT BLADE BENDS ONLY SLIGHTLY, CAUSING POINTER TO SHOW EMPTY

2. BALANCING COIL TYPE

SHOW: TRANSPARENCY FIG. 559

1. ALSO CALLED ELECTROMAGNETIC GAUGE
2. HAS TWO MAGNETIC CIRCUITS WITH COILS TO PRODUCE MAGNETIC FIELDS
3. MAGNETIC FIELDS ACT ON GAUGE POINTER
4. "EMPTY" COIL PRODUCES WEAK BUT CONSTANT FIELD ATTRACTING THE POINTER
5. TANK UNIT HAS SLIDING CONTACT WITH LENGTH OF RESISTOR

6. FLOAT SPECIFIES AMOUNT OF RESISTANCE IN CIRCUIT BY MOVING THE SLIDING CONTACT
7. LOWERING FUEL LEVEL REDUCES CIRCUIT RESISTANCE
8. STRONGER MAGNETIC FIELD PRODUCED IN "FULL" COIL AS FLOAT RISES, WEAKENS AS IT DROPS
9. MARKS ON DASH GAUGE APPROXIMATE FUEL LEVEL

F. FUEL LINE

1. USUALLY COMPOSED OF DURABLE STEEL TUBING
2. CLIPS ATTACH TO FRAME FOR SUPPORT AND PROTECTION
3. SEGMENTS CONNECTED BY HOSE IN VARIOUS PLACES MAY BE USED TO PROVIDE FLEXIBILITY
4. CONNECT FUEL TANK TO FUEL PUMP THEN TO CARBURETOR
5. BROKEN, DENTED, OR CORRODED SEGMENTS REPLACED WITH NEW TUBING OR HOSE
6. SHOULD BE CLEANED WHEN TANKS ARE CLEANED

G. SERVICE CONSIDERATIONS

1. CLEANING OR OTHER WORK ON TANK MAY REQUIRE ITS REMOVAL
2. SHOULD BE COMPLETELY DRAINED OF FUEL
3. SOME TANKS HAVE DRAIN PLUG, BUT IF NOT:
    a. SIPHON MADE OF 1/2 INCH RUBBER TUBING
    b. ONE END MADE HEAVY BY INSERTING
    c. SLIT IN HOSE NEAR OTHER END ALLOWS AIR GUN NOZZLE INSERTION
    d. BLOWING AIR TOWARD OPEN END CREATES VACUUM PULLING OUT FUEL

CAUTION: NEVER SIPHON A TANK BY STARTING A VACUUM BY MOUTH. GASOLINE IN THE LUNGS CAN CAUSE PNEUMONIA AND DEATH

4. SEVERE DENT IN TANK MAY BE REMOVED BY:
    a. REMOVING AND FILLING TO TOP WITH WATER
    b. WITH NONVENTED CAP ON FILLER NECK AND VENT LINE PLUGGED
    c. AIR IS INJECTED IN PICKUP LINE UNTIL DENT POPS OUT

    CAUTION: USING AIR ALONE CAN CAUSE THE TANK TO EXPLODE VIOLENTLY
5. BRAZING OR SOLDERING USED TO REPAIR LEAKS AFTER PROPER SAFETY MEASURES TAKEN
    a. TANK THOROUGHLY DRAINED AND STEAM CLEANED INSIDE AND OUT
    b. AFTER CLEANING, TANK FILLED WITH NONEXPLOSIVE GAS
        (1) CARBON DIOXIDE
        (2) NITROGEN
    c. TANK MAY ALSO BE FILLED WITH WATER AFTER CLEANING

    CAUTION: UNSAFE PRACTICES CAN TURN A GASOLINE TANK INTO A LETHAL BOMB CAPABLE OF KILLING OR MAIMING PEOPLE NEARBY

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK DISCUSSION QUESTIONS TO STRENGTHEN CONCEPTS PRESENTED IN THE LESSON AND EXPLAIN ANY QUESTIONS ARISING FROM THE READING ASSIGNMENT.

EXAMPLE: WHAT CHANGES HAVE TAKEN PLACE IN GASOLINE TANK VENTILATION SYSTEMS OVER THE YEARS?

ANSWER: TANKS WERE ONCE VENTED TO THE ATMOSPHERE, BUT CONCERN FOR AIR POLLUTION AND SMOG PROMPTED DEVELOPMENT OF A CLOSED VENT SYSTEM. THIS WAS THE VEHICLE VAPOR RECOVERY SYSTEM WHICH TRAPS THE VAPOR, TURNS IT BACK INTO LIQUID, AND RETURNS THE FUEL TO THE GASOLINE TANK.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE TEST

1. PROPANE REQUIRES A MUCH STRONGER TANK THAN GASOLINE. T
2. BAFFLES ATTACH THE TANK TO THE REAR OF THE FRAME. F
3. GASOLINE TANKS WERE VENTED TO THE ATMOSPHERE IN 1960. T
4. A VAPOR TRAP IS AN IMPORTANT PART OF THE VVR SYSTEM. T
5. PAPER, CERAMIC, AND BRONZE MAY BE USED TO MAKE FUEL FILTERS. T
6. BALANCING COIL AND THERMOSTATIC ARE TERMS USED TO DESCRIBE VENTILATION SYSTEMS. F
7. ELECTROMAGNETIC IS ANOTHER NAME FOR A THERMOSTATIC FUEL GAUGE. F
8. A BALANCING COIL AND A HEATING COIL OPERATE ON THE SAME PRINCIPLE IN DIFFERENT TYPES OF GAUGES. F
9. PNEUMONIA AND DEATH CAN RESULT FROM GASOLINE IN THE LUNGS. T
10. NITROGEN IS A GAS THAT WILL NOT EXPLODE. T

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

FUEL TANKS VARY IN SIZE AND DESIGN DEPENDING UPON THE VEHICLE AND TYPE OF FUEL IT WILL CONTAIN. THEY ARE USUALLY LOCATED IN THE REAR OF THE FRAMEWORK WHERE THERE IS MAXIMUM PROTECTION AND CONNECTED TO THE FUEL PUMP BY STEEL TUBING.

THE VENTILATION SYSTEM ON OLDER MODELS ALLOWED GASOLINE FUMES TO ESCAPE INTO THE AIR, BUT SINCE THIS CONTRIBUTED TO SMOG CARS NOW HAVE THE VVR SYSTEM THAT RETURNS GAS VAPORS TO THE FUEL TANK.

FOREIGN MATERIAL SUCH AS DIRT AND RUST CAN RUIN THE OPERATING EFFICIENCY OF THE FUEL PUMP AND CARBURETOR. MOST VEHICLES HAVE ONE OR MORE FILTERS OF VARIOUS TYPES TO CLEAN THE FUEL BEFORE IT REACHES THEM.

THERE ARE TWO TYPES OF FUEL GAUGES: BALANCING COIL AND THERMOSTATIC. BOTH OPERATE ON BATTERY CURRENT THROUGH THE IGNITION SWITCH. THE THERMOSTAT TYPE OPERATES ON THE PRINCIPLE OF HEATING

COILS BENDING BLADES WHICH OPEN AND CLOSE POINTS. THIS CAUSES THE POINTER TO RISE OR FALL. BALANCING COIL GAUGES WORK ON VARIANCE OF MAGNETIC FIELDS PRODUCED BY COILS ON EITHER SIDE OF THE GAUGE POINTER. THE POSITION OF THE TANK FLOAT IS RELAYED TO THE DASH UNIT IN BOTH TYPES.

FUEL LINES ARE RELATIVELY TROUBLE FREE EXCEPT FOR CLEANING WHEN FOULED AND CHANGING THE FILTER PERIODICALLY.

VARIOUS SERVICE PROCEDURES ARE DISCUSSED INCLUDING DRAINING, CLEANING, SOLDERING, AND SEVERE DENT REMOVAL. THE DANGERS INVOLVED IN WORKING WITH GASOLINE AND GASOLINE TANKS CANNOT BE OVERLY STRESSED.

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, GLENN, CH. 6

THE NEXT LESSON IS: VIII-C-22(I) "FUEL PUMP"

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | SERVICE FUEL TANK FOR 1975 FORD AND MERCURY |
| AIM: | STUDENT WILL BE ABLE TO SAFELY REMOVE, CLEAN OUT, REINSTALL, OR REPLACE FUEL TANK AND COMPONENT PARTS. STUDENT WILL BE ABLE TO DIAGNOSE FUEL TANK PROBLEMS. |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SIPHON HOSE, CLOSED CONTAINER, FLOOR JACK, 4 JACK STANDS OR FLOOR LIFT, FIRE EXTINGUISHER, STEAM CLEANER |
| MATERIALS: | CLEAN RAGS AND "SORB ALL" FLOOR CLEANER |
| TEACHING AIDS: | TRANSPARENCIES: I ED. II 7 T FIGS. 556, 557, 558, 559 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE LEARNER MUST HAVE KNOWLEDGE OF DANGER INVOLVED WHILE WORKING WITH GASOLINE.<br>THE LEARNER MUST KNOW HOW TO USE FIRE FIGHTING EQUIPMENT.<br>THE LEARNER MUST BE ABLE TO BRAZE WITH ACETYLENE OXYGEN TORCH. |
| REFERENCES: | AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-1 TO 20-3<br>MANUFACTURER'S INSTRUCTION MANUAL OF CAR AT HAND |
| CHECKING STANDARDS: | 1. OBSERVATION OF SAFETY STANDARDS<br>2. PROPER TOOLS AND USE<br>3. FOLLOWS DIRECTIONS<br>4. COMPLETION OF TASK TO PRESCRIBED OBJECTIVES |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE FUEL TANK HAS TO BE REMOVED TO:

1. CLEAN OUT CORROSION AND TRASH
2. REPAIR LEAKS
3. REPAIR FUEL GAUGE SENDING UNIT (SOME MAKES AND MODELS)

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## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. DEMONSTRATE | 1. PERFORM ALL STEPS<br>2. MAKE ALL KEY POINTS CLEAR AND PRECISE |

| | |
|---|---|
| | 3. EMPHASIZE SAFETY |
| 2. PERFORM VEHICLE SAFETY | 1. DISCONNECT STORAGE BATTERY<br>a. PREVENT ACCIDENTAL STARTING OF ENGINE<br>b. ELIMINATE ELECTRICAL SHORTS<br>NOTE: STRESS CARE IN REMOVAL OF BATTERY CABLES<br>2. USE BATTERY PLIERS<br>NOTE: IF NECESSARY USE TERMINAL PULLER TO REMOVE BATTERY CABLES<br>a. REMOVE GROUND CABLE FIRST TO ELIMINATE SPARKS<br>b. REMOVE POSITIVE CABLE LAST<br>3. SET FOOT OR HAND BRAKE IN VEHICLE |
| 3. RAISE FRONT OF VEHICLE | 1. POSITION JACK RAM DIRECTLY UNDER FRAME OR CROSSMEMBERS<br>2. ALIGN FOR PROPER BALANCE<br>CAUTION: MAKE SURE JACK IS PROPERLY ALIGNED UNDER FRAME OR CROSSMEMBERS<br>CAUTION: MAKE SURE JACK RAM IS IN FIRM CONTACT WITH FRAME<br>3. BLOCK REAR WHEELS<br>4. RAISE TO MAXIMUM HEIGHT |
| 4. LOWER VEHICLE ON STANDS | 1. POSITION STANDS UNDER FRAME ON BOTH SIDES OF CAR<br>2. LOWER VEHICLE TO STANDS<br>CAUTION: MAKE SURE FRAME IS ON STAND AND STANDS ARE SQUARE WITH FLOOR<br>3. REMOVE JACK |
| 5. RAISE REAR OF VEHICLE | 1. POSITION JACK<br>NOTE: BE SURE JACK IS PROPERLY ALIGNED UNDER DIFFERENTIAL<br>2. RAISE HIGH ENOUGH TO LEVEL VEHICLE<br>3. POSITION JACK STANDS UNDER AXLE HOUSING<br>4. LOWER VEHICLE TO STANDS<br>CAUTION: MAKE SURE AXLE HOUSING IS STRAIGHT ON STANDS AND THE STANDS ARE SQUARE WITH FLOOR |

| | |
|---|---|
| 6. MAKE SAFETY INSPECTION | 1. INSPECT FOR OPEN FLAMES IN THE SHOP<br>2. OPEN ALL WINDOWS AND DOORS<br>3. TURN ON FANS IF AVAILABLE |
| 7. REMOVE GAS FROM TANK | 1. SIPHON OR PUMP OUT GASOLINE FROM MAIN AND AUXILIARY FUEL TANKS<br>2. DRAIN INTO SAFE GAS CONTAINER<br>3. DISCONNECT AUXILIARY TANK FROM MAIN TANK DRAIN HOSE<br>CAUTION: CARE SHOULD BE TAKEN TO PREVENT SPILLAGE SHOULD TANK NOT BE COMPLETELY DRAINED |
| 8. REMOVE TANK | 1. REMOVE VAPOR LINE FROM FUEL TANK<br>2. DISCONNECT MAIN SUPPLY LINE<br>3. DISPLACE HOSE CLAMPS<br>NOTE: USE PLIERS<br>4. DISCONNECT GROUND CABLES AND CABLE AND GAUGE WIRE<br>5. REMOVE FILLER NECK RETAINING SCREW<br>NOTE: USE PROPER SIZE SCREWDRIVER<br>6. REMOVE FILLER NECK BY PULLING FROM TANK<br>7. UNSCREW TANK SUPPORT STRAP NUTS<br>NOTE: USE PROPER SOCKET<br>8. SUPPORT TANK AND LOWER TO THE FLOOR<br>9. REMOVE GAUGE UNIT<br>10. TURN OUT LOCK RING<br>11. DISCARD SEAL |
| 9. CLEAN AND INSPECT | 1. LOCATE TANK AWAY FROM FLAME, HEAT, OR ANY OTHER SOURCE OF IGNITION<br>2. COMPLETE DRAINING OF TANK BY ROCKING AND ALLOW FUEL TO RUN OUT UNIT HOLE<br>3. PURGE TANK WITH STEAM OR RUNNING HOT WATER AT LEAST FIVE MINUTES<br>WARNING: THIS PROCEDURE WILL NOT REMOVE ALL FUEL VAPOR. DO NOT ATTEMPT ANY REPAIR ON TANK OR FILLER NECK WHERE HEAT OR OPEN FLAME IS REQUIRED |

| | |
|---|---|
| 10. INSTALL FUEL TANK | 1. INSTALL FUEL GAUGE UNIT, USE NEW SEAL<br>2. POSITION TANK IN PLACE<br>3. INSTALL FUEL TANK SUPPORT STRAPS<br>4. INSTALL NUTS ON STRAP BOLTS<br>5. CONNECT VAPOR LINE TO FUEL TANK<br>6. CONNECT MAIN FUEL SUPPLY LINE TO FITTING<br>7. MOVE CLAMP INTO PLACE<br>8. CONNECT GROUND STRAP AND GAUGE WIRE<br>9. INSTALL GAS FILLER PIPE<br>10. INSTALL ATTACHING SCREW<br>11. SIPHON OR PUMP GASOLINE INTO TANK |
| 11. REMOVE VEHICLE FROM STANDS | 1. PLACE JACK RAM UNDER DIFFERENTIAL<br>CAUTION: BE SURE JACK RAM IS SQUARE UNDER DIFFERENTIAL AND LIFTS VEHICLE STRAIGHT UP<br>2. RAISE VEHICLE UNTIL JACK STANDS ARE CLEAR<br>3. REMOVE JACK STANDS AND PLACE IN STORAGE<br>4. LOWER VEHICLE<br>5. REMOVE JACK<br>6. POSITION JACK UNDER CROSSMEMBER OR FRAME IN FRONT<br>CAUTION: MAKE SURE JACK RAM IS SQUARE WITH AND IN CENTER OF CROSSMEMBER OR FRAME<br>7. LIFT VEHICLE TO CLEAR JACK STANDS<br>8. REMOVE JACK STANDS AND PLACE IN STORAGE<br>9. LOWER VEHICLE TO FLOOR<br>10. REMOVE JACK AND PLACE IN STORAGE |
| 12. REMOVE VEHICLE | 1. REMOVE VEHICLE FROM STALL<br>2. PLACE IN PARKING AREA |
| 13. CLEAN WORK STATION | 1. CLEAN TOOLS AND RETURN TO STORAGE<br>2. RETURN EQUIPMENT TO STORAGE<br>3. SWEEP WORK STATION |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO REPEAT ALL STEPS OF THE TASK.

## III. APPLICATION (CON'T.)

2. STUDENTS TO POINT OUT SAFETY AND HAZARD PRECAUTIONS.
3. CHECK STUDENTS FOR KEY POINTS.
4. STUDENTS TO PRACTICE ON TASK.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK (PERFORMANCE TEST)

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

1. REPEAT STEPS FROM STAGE II.
2. EMPHASIZE SAFETY AND CAUTIONS OF KEY POINTS IN STAGE II.
3. REEMPHASIZE PERTINENT KEY POINTS FROM STAGE II.
4. EMPHASIZE CHECKING STANDARDS FOR THE TASK.

SUGGESTED READING FOR STUDENTS:

AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-1 TO 20-3
MANUFACTURER'S REPAIR MANUAL OF VEHICLE AT HAND

THE NEXT LESSON IS: VIII-C-18(S) "REMOVE AND REPLACE FUEL PUMP"

VIII-C-17(J)

# JOB SHEET
IN
FUEL SYSTEM

**JOB:** SERVICE FUEL TANK

**MATERIALS:** CLEAN RAGS, "SORB ALL", LAUNDRY SOAP

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS, STEAM CLEANER, FLOOR JACK, 4 JACK STANDS OR FLOOR LIFT, SIPHON HOSE OR PUMP, SAFETY GAS CAN

**GENERAL INSTRUCTIONS:** BEFORE DOING THIS JOB STUDENTS MUST REVIEW SAFETY RULES TO HANDLE GASOLINE

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-C-17(TS) | PERFORM VEHICLE SAFETY |
| VIII-C-17a(TS) | PLACE VEHICLE ON STANDS |
| VIII-C-17b(TS) | REMOVE FUEL TANK |
| VIII-C-17c(TS) | CLEAN AND INSPECT FUEL TANK |
| VIII-C-17d(TS) | INSTALL MAIN FUEL TANK |
| VIII-C-17e(TS) | REMOVE VEHICLE FROM JACK STANDS |
| VIII-C-17f(TS) | MAKE VEHICLE READY |
| VIII-C-17g(TS) | CLEAN WORK STATION |

**CHECK POINTS:**

1. OBSERVE SAFETY RULES AND SHOP POLICIES AND REGULATIONS
2. USE TOOLS IN PROFESSIONAL AND CRAFTSMANLIKE MANNER
3. TAKE MENTAL NOTES OF ALL NEW TASKS AT HAND

## TASK SHEET VIII-C-17(TS)

TASK: PERFORM VEHICLE SAFETY

JOB: SERVICE FUEL TANK

TRADE: AUTO MECHANICS

TOOLS AND MATERIALS: BATTERY PLIERS, BATTERY CABLE TERMINALS, PULLER, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. CAREFULLY DRIVE VEHICLE IN WORK STALL<br>2. CUT OFF ENGINE<br>3. REMOVE IGNITION KEY<br>NOTE: GIVE KEY TO INSTRUCTOR FOR PROPER FILING |
| 2. DISCONNECT STORAGE BATTERY<br>A. PREVENTS ACCIDENTAL STARTING OF ENGINE<br>B. ELIMINATES ELECTRICAL SHORTS | 1. RAISE HOOD<br>NOTE: SUPPORT HOOD WITH SUPPORT ROD IF APPLICABLE TO VEHICLE<br>2. LOOSEN GROUND CABLE AND REMOVE<br>NOTE: TO PREVENT ACCIDENTAL SHORTS WHILE REMOVING CABLES<br>3. DISCONNECT POSITIVE CABLE |

## TASK SHEET

VIII-C-17a(TS)

**TASK:** PLACE VEHICLE ON STANDS

**JOB:** SERVICE FUEL TANK

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** FLOOR JACK, 4 JACK STANDS OR FLOOR LIFT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION FLOOR JACK UNDER VEHICLE | 1. SET JACK RAM DIRECTLY UNDER THE FRAME OR CROSSMEMBER<br>2. ALIGN JACK RAM FOR PROPER WEIGHT DISTRIBUTION<br>a. PLACE JACK IN CENTER OF CROSSMEMBER<br>b. PLACE JACK RAM ON FLAT PART OF FRAME OR CROSSMEMBER<br>3. HAVE OBSERVING PERSONS STAND CLEAR |
| 2. RAISE FRONT END OF VEHICLE | 1. BLOCK REAR WHEELS<br>a. PLACE WHEEL BLOCKS BEHIND REAR WHEELS<br>b. PLACE BLOCK IN CONTACT WITH REAR WHEEL<br>2. TURN JACK FLUID RELEASE VALVE TO RIGHT (CLOCKWISE)<br>a. TURN UNTIL SNUG TIGHT<br>b. ACTIVATES THE JACK HYDRAULIC PRESSURE<br>3. MOVE JACK HANDLE UP AND DOWN UNTIL JACK RAM CONTACTS FRAME OR CROSSMEMBER<br>a. CHECK TO MAKE SURE RAM IS IN GOOD CONTACT WITH FRAME OR CROSSMEMBER<br>b. IF THE JACK NEEDS TO BE MOVED TURN RELEASE VALVE TO LEFT (COUNTERCLOCKWISE) AND READJUST JACK POSITION<br>4. MOVE THE JACK UP AND DOWN (HEREAFTER STATED PUMP THE JACK HANDLE) UNTIL JACK RAM REACHES ITS |

| STEPS | KEY POINTS |
|---|---|
|  | MAXIMUM HEIGHT |
| 4. LOWER FRONT END OF VEHICLE ON STANDS | 1. POSITION SAFETY STANDS UNDER FRAME DIRECTLY BEHIND FRONT WHEELS<br>2. RAISE STAND EXTENSIONS AS HIGH AS POSSIBLE<br>a. CHECK AND MAKE SURE STAND EXTENSION LOCK IS SECURELY IN PLACE<br>b. VISUALLY CHECK TO MAKE SURE STANDS ARE DIRECTLY UNDER FRAME AND STANDS ARE SQUARE WITH FLOOR<br>3. TURN JACK RELEASE VALVE TO LEFT<br>CAUTION: TURN RELEASE VALVE SLOWLY<br>NOTE: MAKE SURE FRAME RESTS SQUARELY ON JACK STANDS<br>4. REMOVE JACK |
| 5. RAISE REAR END OF VEHICLE | 1. SET JACK RAM UNDER FRAME OR CROSSMEMBER<br>2. ALIGN JACK FOR PROPER WEIGHT DISTRIBUTION<br>NOTE: PLACE JACK IN CENTER OF CROSSMEMBER<br>NOTE: PLACE JACK RAM UNDER FRAME ON FLAT PART OF FRAME<br>3. TURN JACK FLUID RELEASE VALVE TO THE RIGHT<br>4. PUMP JACK HANDLE UNTIL JACK RAM CONTACTS FRAME OR CROSSMEMBER<br>NOTE: CHECK TO MAKE SURE RAM IS IN GOOD CONTACT WITH FRAME OR CROSSMEMBER<br>NOTE: IF THE JACK NEEDS TO BE MOVED TURN RELEASE VALVE TO LEFT AND ADJUST JACK POSITION THEN RETIGHTEN FLUID RELEASE VALVE<br>5. PUMP JACK HANDLE UNTIL JACK RAM REACHES ITS MAXIMUM HEIGHT |
| 6. LOWER REAR OF VEHICLE ON STANDS | 1. POSITION STANDS UNDER FRAME DIRECTLY BEHIND REAR WHEELS<br>2. RAISE STAND EXTENSIONS AS HIGH AS POSSIBLE |

| STEPS | KEY POINTS |
|---|---|
| | CAUTION: CHECK AND MAKE SURE STAND EXTENSION LOCK IS SECURELY IN PLACE |
| | NOTE: VISUALLY CHECK TO MAKE SURE STANDS ARE DIRECTLY UNDER FRAME AND STANDS ARE SQUARE WITH FLOOR |
| | 3. TURN JACK RELEASE VALVE TO LEFT (COUNTERCLOCKWISE) |
| | CAUTION: BE VERY CAREFUL TO TURN RELEASE VALVE SLOWLY |
| | NOTE: MAKE SURE THE FRAME RESTS SQUARELY ON STANDS |
| | 4. REMOVE JACK AND RETURN TO STORAGE |

TASK SHEET VIII-C-17b(TS)

TASK: REMOVE FUEL TANK

JOB: SERVICE FUEL TANK

TRADE: AUTOMECHANICS

TOOLS AND EQUIPMENT: BASIC HAND TOOLS, SAFETY GOGGLES, DROP LIGHT, SIPHON HOSE OR GASOLINE PUMP, SAFETY CAN

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE GASOLINE FROM TANK | CAUTION: MAKE SURE THERE ARE NO OPEN FLAMES IN SHOP<br>1. SIPHON OR PUMP OUT GASOLINE FROM TANK<br>CAUTION: CARE SHOULD BE TAKEN TO PREVENT SPILLAGE SHOULD TANK NOT BE COMPLETELY DRAINED |
| 2. DISCONNECT MAIN SUPPLY LINE | 1. USE PLIERS TO MOVE HOSE CLAMP TO CENTER OF HOSE<br>2. TWIST AND PULL HOSE OFF FITTING |
| 3. DISCONNECT GROUND CABLE AND GAUGE WIRE | 1. USE PLIERS TO UNFASTEN GROUND WIRE CLIPS<br>2. PULL GAUGE WIRE OFF OF FITTING |
| 4. REMOVE FILLER NECK | 1. REMOVE RETAINING SCREW<br>a. USE PROPER SIZE SCREWDRIVER<br>b. TURN TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE SCREWS IN CONTAINER<br>2. PULL FILLER TUBE OUT OF TANK |
| 5. DISCONNECT TANK SUPPORT STRAPS | 1. UNSCREW TANK SUPPORT STRAP NUTS<br>a. USE PROPER SOCKET AND RATCHET<br>b. TURN NUTS TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE NUTS IN CONTAINER<br>2. SUPPORT TANK AND REMOVE STRAPS<br>3. LOWER TANK TO FLOOR |
| 6. REMOVE GAUGE UNIT | 1. TURN LOCKING RING TO LEFT<br>2. LIFT OUT GAUGE<br>3. DISCARD SEAL |

## TASK SHEET

VIII-C-17c(TS)

| | |
|---|---|
| TASK: | CLEAN AND INSPECT FUEL TANK |
| JOB: | SERVICE FUEL TANK |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | SCRAPER, SAFETY GOGGLES, STEAM CLEANER, HOT WATER |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE OUTSIDE DIRT | 1. SCRAPE OFF EXCESS WITH SCRAPER<br>2. WASH WITH SOLVENT BRUSH |
| 2. REMOVE FUMES AND VAPORS | 1. WASH WITH RUNNING HOT WATER FOR FIVE MINUTES<br>2. STEAM CLEAN INSIDE AND OUT FOR AT LEAST FIVE MINUTES |
| 3. CHECK FOR HOLES OR CRACKS | 1. VISUALLY INSPECT OUTSIDE FOR ANY LEAK<br>2. MARK THE DAMAGED SPOT CLEARLY |

## TASK SHEET

VIII-C-17d(TS)

**TASK:** INSTALL MAIN FUEL TANK

**JOB:** SERVICE FUEL TANK

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, CLEAN RAGS, SAFETY GOGGLES, DROP LIGHT

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. INSTALL FUEL GAUGE | 1. POSITION FUEL GAUGE WITH NEW SEAL |
| | 2. INSTALL LOCKING RING |
| | a. USE PROPER SCREWDRIVER |
| | b. TURN LOCKING RING TO RIGHT (CLOCKWISE) |
| | c. TURN UNTIL AGAINST STOPS |
| 2. POSITION TANK | 1. RAISE TANK INTO PLACE |
| | 2. INSTALL RETAINER STRAPS |
| | 3. INSTALL RETAINER STRAP NUTS |
| | a. USE PROPER SOCKET AND RATCHET |
| | b. TURN NUTS TO RIGHT (CLOCKWISE) |
| | c. TIGHTEN TO SPECIFICATIONS |
| | 4. PUSH VAPOR LINE ONTO TANK FITTING |
| | 5. PUSH MAIN FUEL LINE ONTO FITTING |
| | 6. SECURE WITH CLAMP |
| | a. USE PLIERS |
| | b. MOVE CLAMP INTO PROPER LOCATION |
| | 7. CLAMP GROUND WIRE ONTO GAUGE UNIT |
| | 8. PLUG ON GAUGE WIRE |
| 3. INSTALL FILLER PIPE | 1. PUSH FILLER PIPE INTO PLACE USING NEW SEAL |
| | 2. INSTALL RETAINING SCREW |
| | a. USE PROPER SCREWDRIVER |
| | b. TURN SCREW TO RIGHT (CLOCKWISE) |
| | c. TIGHTEN TO SPECIFICATIONS |
| | 3. SIPHON OR PUMP IN GASOLINE |
| | 4. REPLACE GAS TANK CAP |

## TASK SHEET

VIII-C-17e(TS)

**TASK:** REMOVE VEHICLE FROM JACK STANDS

**JOB:** SERVICE FUEL TANK

**TRADE:** AUTOMECHANIC

**TOOLS AND MATERIALS:** FLOOR JACK, 4 JACK STANDS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. LOWER REAR OF VEHICLE | 1. PLACE JACK RAM UNDER DIFFERENTIAL<br>CAUTION: BE SURE JACK RAM IS SQUARE UNDER DIFFERENTIAL AND LIFTS VEHICLE STRAIGHT UP<br>2. RAISE VEHICLE UNTIL JACK STANDS ARE CLEAR<br>3. REMOVE JACK STANDS AND PLACE IN STORAGE<br>4. LOWER VEHICLE<br>5. REMOVE JACK |
| 2. LOWER FRONT OF VEHICLE | 1. POSITION JACK RAM UNDER FRONT OF VEHICLE ON FRAME OR CROSSMEMBER<br>CAUTION: MAKE SURE JACK IS IN FIRM CONTACT WITH FRAME OR CROSSMEMBER AT CENTER AND ON FLAT PART<br>2. LIFT VEHICLE TO CLEAR STANDS<br>3. REMOVE STANDS AND PLACE IN STORAGE<br>4. LOWER VEHICLE TO FLOOR<br>5. REMOVE JACK AND PLACE IN STORAGE |

# TASK SHEET

**TASK:** MAKE VEHICLE READY

**JOB:** SERVICE FUEL TANK

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BATTERY PLIERS, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. CONNECT BATTERY | 1. CONNECT POSITIVE BATTERY CABLE<br>a. USE BATTERY PLIERS<br>b. TURN NUT TO RIGHT (CLOCKWISE)<br>2. CONNECT BATTERY GROUND CABLE<br>a. USE BATTERY PLIERS<br>b. TURN NUT TO RIGHT (CLOCKWISE)<br>c. TIGHTEN TO SPECIFICATIONS<br>3. REMOVE ALL TOOLS FROM VEHICLE<br>4. START ENGINE, CHECK FOR LEAKS<br>5. REPAIR LEAKS IF ANY<br>6. CLOSE HOOD<br>7. TURN IGNITION OFF |

## TASK SHEET

VIII-C-17g(TS)

**TASK:** CLEAN WORK STATION

**JOB:** SERVICE FUEL TANK

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** CLEAN RAGS, FLOOR BROOM, DUST PAN

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE VEHICLE | 1. REMOVE VEHICLE FROM STALL<br>2. PLACE IN PARKING AREA |
| 2. CLEAN WORK STATION | 1. CLEAN TOOLS AND RETURN TO STORAGE<br>2. RETURN EQUIPMENT TO STORAGE<br>3. SWEEP WORK STATION<br>4. PICK UP RESIDUE AND PLACE IN TRASH CAN<br>5. RETURN CLEANING TOOLS TO STORAGE |

VIII-C-22(I)

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | FUEL PUMP |
| AIM: | THE STUDENT WILL BE ABLE TO COMPARE TYPES OF FUEL PUMPS AND DESCRIBE THEIR COMPONENTS AND OPERATION. |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T, FIGS. 556 AND 560<br>USED FUEL PUMPS<br>CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, CHS. 9 AND 20<br>AUTOMECHANICS, GLENN, CH. 6<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 20<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 225-270 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT SHOULD HAVE SATISFACTORILY COMPLETED THE LESSON ON FUEL TANKS. |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

SEVERAL METHODS HAVE BEEN TRIED IN SUPPLYING AUTOMOTIVE ENGINES WITH THE NECESSARY QUANTITY OF FUEL. THE FIRST USED GRAVITY AND ATMOSPHERIC PRESSURE BUT THIS WAS DISCARDED. IT PROVIDED TOO LITTLE FUEL ON STEEP HILLS AND WAS DANGEROUS BECAUSE IT REQUIRED PLACING THE TANK ABOVE AND RELATIVELY CLOSE TO THE ENGINE. NEXT, PRESSURIZED FUEL TANKS WERE USED. THEY WERE TOO COMPLEX TO BE VERY PRACTICAL AND REQUIRED AN AIR TIGHT TANK. THE DEVELOPMENT OF A DEVICE THAT PULLED FUEL FROM THE TANK AND PUSHED IT INTO THE CARBURETOR AS IT WAS NEEDED SOLVED THE PROBLEM. THIS DEVICE IS THE SUBJECT OF OUR LESSON TODAY: THE FUEL PUMP.

## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. FUNCTION OF FUEL PUMP | 1. PURPOSE IS TO SUPPLY FUEL TO CARBURETOR<br>a. PULLS IN FUEL FROM TANK BY VACUUM<br>b. PUSHES FUEL OUT UNDER PRESSURE<br>2. KEEPS CARBURETOR RESERVOIR FULL |

- a. NEEDLE VALVE AND FLOAT CONTROL LEVEL OF FUEL
- b. PUMPING ACTION STOPS WHEN VALVE CLOSES

B. TYPES

1. ELECTRIC FUEL PUMPS ON HEAVY DUTY VEHICLES
   - a. TRUCKS AND BUSES MAY HAVE THIS TYPE
   - b. SOME ARE LOCATED INSIDE FUEL TANK

SHOW: TRANSPARENCY FIG. 560

   - c. ELECTRIC MOTOR OPERATES ON BATTERY CURRENT
   - d. PUMPING MECHANISM IS VARIABLE
     - (1) PLUNGER MAY PRODUCE PRESSURE
     - (2) IMPELLER SPINS FORCING THE FUEL OUT
     - (3) BELLOWS DESIGN GIVES CONSTANT PRESSURE
     - (4) DIAPHRAGM TYPE SIMILAR TO MECHANICAL PUMP
   - e. SAME BASIC OPERATION AS MECHANICAL TYPE
2. MECHANICAL FUEL PUMP MOST COMMON ON CARS
   - a. DESIGN IS SOMEWHAT VARIABLE
   - b. ALL FUNCTION IN THE SAME MANNER
   - c. OLDER TYPES HAD VACUUM BOOSTER FOR WINDSHIELD WIPER
   - d. COMBINATION TYPE PUMPED BOTH FUEL AND AIR

C. CONSTRUCTION OF MECHANICAL TYPE

1. PUMP HOUSING OR BODY MADE OF LIGHT WEIGHT METAL
   - a. HOUSING HALVES MAY OVERLAP AND CRIMP TOGETHER
   - b. THIS TYPE CANNOT BE REPAIRED AND MUST BE REPLACED WHEN DEFECTIVE
   - c. THOSE BOLTING TOGETHER ARE USUALLY REPAIRABLE
2. ROCKER ARM ASSEMBLY
   - a. ATTACHED IN HOUSING BY PIVOT PIN

  - b. LONGER END EXTENDS OUT OF HOUSING
  - c. RIDES ON ECCENTRIC OF CAMSHAFT OR A PUSH ROD
  - d. INNER END ATTACHES TO PULL ROD
  - e. FLEXIBLE DIAPHRAGM ATTACHED TO END OF PULL ROD
  - f. ROCKER ARM RETURN SPRING INSIDE HOUSING

3. DIAPHRAGM ASSEMBLY
   - a. COMPOSED OF FLEXIBLE MATERIAL
   - b. OUTER EDGE CLAMPED BETWEEN HOUSING HALVES
   - c. CENTER PORTION HELD BETWEEN PLATES
   - d. PLATES ATTACH TO PULL ROD
   - e. SPRING PUSHES AGAINST DIAPHRAGM BOTTOM
4. FUEL PUMP CHAMBER USUALLY LOCATED ABOVE THE DIAPHRAGM
5. VALVE ASSEMBLY
   - a. INLET VALVE ON TANK LINE SIDE OF PUMP
   - b. OUTLET VALVE ON CARBURETOR SIDE
   - c. THREADED HOUSING ALLOWS LINE ATTACHMENT TO EACH VALVE CHAMBER
   - d. SPECIAL OUTLET FOR VAPOR RETURN LINE ON SOME
6. MAY HAVE PULSATOR DIAPHRAGM TO REDUCE SURGES
7. FUEL COVER ABOVE PULSATOR COMPLETES UNIT

D. FUEL PUMP FILTERS

1. SOME CONSTRUCTED WITH REPLACEABLE FILTERS ON OUTSIDE
2. SEDIMENT BOWL AND SCREEN WAS ONCE POPULAR
3. VARIOUS TYPES OF INTERNAL FILTERS STILL USED

E. PUMP LOCATION

1. MOUNTS ON SIDE OF IN-LINE ENGINES
   - a. OPENING PROVIDED IN CYLINDER BLOCK

SHOW: TRANSPARENCY
FIG. 556

   b. ROCKER ARM EXTENDS INSIDE
   c. PUMP HOUSING BOLTS TO BLOCK
2. LOCATION VARIABLE ON V-8 ENGINES
   a. MAY MOUNT BETWEEN CYLINDER BANKS
   b. MOST MOUNT ON SIDE NEAR FRONT

F. OPERATION

1. ECCENTRIC ON CAMSHAFT DRIVES ROCKER ARM
2. PUSH ROD BETWEEN ECCENTRIC AND ROCKER ARM WHERE PUMP CENTRALLY MOUNTED ON V-8
3. ECCENTRIC TURNS CAUSING BACK AND FORTH MOVEMENT OF ROCKER ARM
4. SPRING ON ROCKER ARM KEEPS IT IN CONTACT WITH ECCENTRIC
5. LINKAGE CONNECTS ROCKER ARM TO DIAPHRAGM
6. SPRING LOADED DIAPHRAGM TRIES TO STAY IN UP POSITION
7. DIAPHRAGM PULLED DOWN BY ROCKER ARM
8. VACUUM CREATED IN PUMP CHAMBER
9. INLET VALVE FORCED OPEN BY VACUUM
10. ATMOSPHERIC PRESSURE PUSHES FUEL INTO CHAMBER
11. HIGH POINT OF ECCENTRIC ROTATES AWAY FROM ROCKER ARM
12. ROCKER ARM RELEASES DIAPHRAGM
13. SPRING UNDER DIAPHRAGM PUSHES IT UPWARD
14. SEVERAL POUNDS PRESSURE EXERTED ON CHAMBER
15. INLET VALVE CLOSES AND OUTLET VALVE OPENS
16. FUEL FORCED OUT INTO LINE TO CARBURETOR
17. CARBURETOR RESERVOIR TAKES IN FUEL
18. FLOAT AND NEEDLE VALVE CUT OFF FLOW WHEN FULL
19. CARBURETOR RESERVOIR TAKES IN FUEL
20. FLOAT AND NEEDLE VALVE CUT OFF FLOW WHEN FULL

21. FUEL PUMP CEASES DIAPHRAGM ACTION
22. ROCKER ARM CONTINUES TO OPERATE FUEL FLOWS AGAIN WHEN NEEDLE VALVE OPENS

G. MALFUNCTIONS

1. WEAR MAY CAUSE INTERNAL MALFUNCTION IN THESE PLACES:
    a. VALVES OR VALVE SEATS
    b. PULL ROD AND CONNECTIONS
    c. PUNCTURED OR SPLIT DIAPHRAGM
    d. WORN LINKAGE OR PIVOT PIN
2. FLEXIBLE LINES AND CONNECTIONS MAY LEAK OR SWELL INTERNALLY TO OBSTRUCT FLOW
3. MAY CAUSE CARBURETOR FLOODING BY EXCESSIVE PRESSURES DUE TO TOO RIGID DIAPHRAGM
4. VAPOR LOCK COMMON IN AIR CONDITIONED VEHICLES DUE TO HEATING

H. TESTS

1. VOLUME TESTS CHECK PUMP EFFICIENCY
    a. CRANKING SPEED TEST
        (1) LINE INTO CARBURETOR DISCONNECTED
        (2) FUEL DIRECTED INTO SMALL CONTAINER
        (3) ENGINE CRANKED WITH IGNITION OFF
        (4) PUMP SHOULD YIELD STRONG SPURTS OF FUEL
    b. IDLE SPEED PUMP TEST
        (1) CARBURETOR RESERVE BOWL FILLED
        (2) RESERVOIR FILL UP LINE DISCONNECTED
        (3) FLOW DIRECTED INTO PINT OR QUART CONTAINER
        (4) IDLE SPEED SHOULD PUMP A PINT IN ABOUT 45 SECONDS
2. PRESSURE GAUGE USED TO TEST PUMP
    a. GAUGE CONNECTED TO PUMP OUTLET
    b. CRANKING ENGINE SHOULD PRODUCE 3 TO 5 POUNDS PRESSURE

3. GAUGE USED TO TEST VACUUM SIDE
   a. VACUUM GAUGE CONNECTED TO PUMP INLET
   b. ENGINE OPERATED AT IDLE SPEED
   c. VACUUM SHOULD BE AT LEAST 10 INCHES

CAUTION: EXTREME CARE SHOULD BE TAKEN WHEN RUNNING AN ENGINE WHILE ALLOWING GASOLINE TO FLOW INTO AN OPEN CONTAINER

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

QUESTION STUDENTS ORALLY TO CHECK COMPREHENSION AND STIMULATE DISCUSSION OF THE MATERIAL PRESENTED.

BLANK OUT THE LABELS ON A FUEL PUMP TRANSPARENCY AND, WHILE SHOWING IT ON THE SCREEN, HAVE STUDENTS NAME THE COMPONENTS AND TELL HOW THEY FUNCTION.

HAVE STUDENTS LOCATE THE FUEL PUMPS ON VEHICLES IN THE IMMEDIATE AREA AND GIVE ANY PERTINENT INFORMATION THEY MIGHT KNOW.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

QUESTIONS: SIMPLE RECALL

| | |
|---|---|
| 1. THE PUMP PULLS FUEL INTO THE CHAMBER BY CREATING A _____. | VACUUM |
| 2. FUEL LEVEL IN THE CARBURETOR IS CONTROLLED BY A _____ VALVE. | NEEDLE |
| 3. THE VALVE MENTIONED IN NUMBER TWO IS OPERATED BY A _____ MECHANISM. | FLOAT |
| 4. THERE ARE BASICALLY TWO TYPES OF FUEL PUMPS THEY ARE EITHER _____ OR _____. | MECHANICAL<br>ELECTRICAL |
| 5. THE DIAPHRAGM OF A PUMP IS MADE OF _____ MATERIAL. | FLEXIBLE |
| 6. A ROCKER ARM IS HELD IN THE PUMP HOUSING BY A _____. | PIVOT PIN |

## IV. VERIFICATION (CON'T)

| | | |
|---|---|---|
| 7. | VACUUM IN THE PUMP CHAMBER OPENS THE _____ VALVE. | INLET |
| 8. | ACTION OF THE DIAPHRAGM SPRING OPENS THE _____ VALVE. | OUTLET |
| 9. | A _____ DIAPHRAGM MAY BE USED TO REDUCE FUEL SURGES. | PULSATOR |
| 10. | THE SEDIMENT _____ AND _____ WAS ONCE A POPULAR FUEL FILTER. | BOWL<br>SCREEN |
| 11. | MOVEMENT OF THE ROCKER ARM IS CAUSED BY A CAMSHAFT _____. | ECCENTRIC |
| 12. | FUEL PUMP LOCATION IS VARIABLE ON _____ ENGINES. | V-EIGHT |
| 13. | PRESSURE IS CREATED IN THE PUMP CHAMBER BY A _____. | SPRING |
| 14. | EXCESSIVE PUMP PRESSURE CAN CAUSE THE CARBURETOR TO _____. | FLOOD |
| 15. | FUEL PUMP PRESSURE SHOULD BE FROM _____ TO _____ POUNDS. | 3<br>5 |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE PRIMARY FUNCTION OF A FUEL SYSTEM IS TO KEEP A READY SUPPLY OF FUEL AVAILABLE FOR THE ENGINE. SEVERAL METHODS HAVE BEEN TRIED IN ACCOMPLISHING THIS, BUT THE MOST SUCCESSFUL HAS PROVEN TO BE THE CARBURETOR RESERVOIR AND FUEL PUMP.

FUEL PUMPS ARE BROKEN DOWN INTO TWO BASIC TYPES: MECHANICAL AND ELECTRICAL. ELECTRICAL PUMPS ARE FOUND ON HEAVY DUTY VEHICLES SUCH AS TRUCKS AND BUSES. THE MECHANICAL PUMP IS THE MOST COMMON TYPE FOUND ON CARS.

MECHANICAL FUEL PUMP PARTS ARE: HOUSING, ROCKER ARM ASSEMBLY, DIAPHRAGM ASSEMBLY, PUMP CHAMBER, VALVE ASSEMBLY, AND FUEL COVER. MOST INCORPORATE A FUEL FILTER IN THEIR DESIGN.

LOCATION OF THE PUMP VARIES WITH ENGINE DESIGN, BUT IT IS MOST OFTEN MOUNTED ON THE SIDE OF THE BLOCK.

ATMOSPHERIC PRESSURE AND SPRING PRESSURE ARE USED TO MOVE FUEL FROM THE TANK THROUGH THE PUMP AND INTO A RESERVOIR IN THE CARBURETOR.

## V. SUMMARY (CON'T)

WEAR AND FATIGUE CAN CAUSE A FUEL PUMP TO MALFUNCTION. TESTS FOR FUEL PUMP EFFICIENCY INCLUDE: VOLUME OUTPUT, PRESSURE AT CRANKING SPEED, AND AMOUNT OF VACUUM THE PUMP WILL PRODUCE.

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SUGGESTED READING FOR THE STUDENTS:

AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 245-254

THE NEXT LESSON IS: VIII-C-23(I) "CARBURETOR FUNDAMENTALS"

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-18(S)

**TASK:** REMOVE AND REPLACE FUEL PUMP

**AIM:** STUDENT WILL BE ABLE TO REMOVE AND REPLACE FUEL PUMP
STUDENT WILL BE ABLE TO REPAIR DAMAGED FUEL LINES

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS, SAFETY GOGGLES, DROP LIGHT, FENDER COVER, CLEAN RAGS, NONFLAMMABLE SOLVENT, AND PARTS WASH PAN

**MATERIALS:**

**TEACHING AIDS:** TRANSPARENCIES I. ED. II 7T FIGS, 556, 560

**REFERENCES:** *AUTOMECHANICS*, GLENN, PP. 137-144
*AUTOMOTIVE ENCYCLOPEDIA*, TOBOLDT, PP. 267-271
*AUTO SERVICE AND REPAIR*, STOCKEL, PP. 20-3 TO 20-13

**PREREQUISITE EXPERIENCE OF THE LEARNER:** STUDENT MUST HAVE PASSED INFORMATION TEST SATISFACTORILY, READ THE RELATED MATERIALS AND BE INTERESTED TO CONTINUE WITH MANIPULATIVE SKILLS

**CHECKING STANDARDS:**
1. OBSERVATION OF SAFETY STANDARDS
2. OBSERVATION OF CARING FOR PAINTED SURFACE OF VEHICLE
3. PROPER TOOLS AND USE
4. STUDENT FOLLOWS DIRECTIONS

---

### I. PREPARATION (OF THE LEARNER - MOTIVATION)

WHY REPLACE FUEL PUMP?

1. FAILURE TO SUPPLY GASOLINE TO CARBURETOR
2. LEAKS GASOLINE IN ENGINE COMPARTMENT
3. LEAKS GASOLINE INTO ENGINE CRANKCASE

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### II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PERFORM VEHICLE SAFETY | 1. REFER TO VIII-C-17(TS)<br>2. INSTALL FENDER COVER |
| 2. REMOVE FUEL LINES | 1. DISCONNECT INLET LINE<br>a. USE PLIERS<br>b. RELEASE SPRING CLAMP |

| | |
|---|---|
| | c. MOVE CLAMP TOWARD REAR ON HOSE<br>2. DISCONNECT OUTLET LINE<br>a. USE PROPER LINE WRENCHES<br>b. TURN NUT TO LEFT (COUNTER-CLOCKWISE)<br>c. RETAIN FITTING WITH LINE WRENCH |
| 3. DISCONNECT FUEL PUMP FROM ENGINE | 1. REMOVE FUEL PUMP ATTACHING BOLTS<br>a. USE PROPER SOCKET, SHORT EXTENSION, AND RATCHET<br>b. TURN BOLTS TO LEFT (COUNTER-CLOCKWISE)<br>c. PLACE BOLTS IN CONTAINER<br>2. REMOVE PUMP AND GASKET<br>3. DISCARD GASKET |
| 4. INSTALL FUEL PUMP | 1. REMOVE ALL GASKET MATERIAL FROM MOUNTING PAD AND PUMP<br>2. APPLY OIL-RESISTANT SEALER TO BOTH SIDES OF A NEW GASKET<br>3. POSITION GASKET ON FUEL PUMP FLANGE<br>4. HOLD FUEL PUMP IN POSITION AGAINST MOUNTING PAD<br>CAUTION: MAKE SURE ROCKER ARM OR ROD IS RIDING ON THE CAMSHAFT OR INTERMEDIATE SHAFT ECCENTRIC<br>5. PRESS FUEL PUMP TIGHT AGAINST PAD<br>6. INSTALL ATTACHING BOLTS<br>a. USE PROPER SOCKET AND TORQUE WRENCH<br>b. TURN BOLTS TO RIGHT (CLOCKWISE)<br>c. TIGHTEN TO SPECIFICATIONS |
| 5. CONNECT FUEL INLET HOSE | 1. INSTALL CLAMP ON HOSE<br>NOTE: USE NEW HOSE CLAMP<br>2. INSTALL HOSE ON FITTING<br>3. POSITION CLAMP ON HOSE TO SEAL HOSE TO FITTING |
| 6. CONNECT OUTLET LINE | 1. USE PROPER LINE WRENCHES<br>2. RETAIN FITTING WITH ONE WRENCH AND TURN NUT WITH ANOTHER<br>3. TIGHTEN TO SPECIFICATION<br>NOTE: IF HOSE IS USED AT FUEL PUMP CONNECTION, CRIMP RETAINING CLAMP |

SECURELY

**7. REPAIR FUEL LINE**

1. CUT OUT DAMAGED SECTION OF FUEL LINE
    - a. USE TUBING CUTTER
    - b. REMOVE BURRS ON EDGES
2. FLARE ENDS OF CUT LINE
    - a. USE TUBING FLARING TOOLS
    - b. FORM A DOUBLE FLARE ON EACH END OF FUEL LINE
3. INSTALL PROPER SIZE RUBBER HOSE ON FUEL LINE

    NOTE: TWO INCH OVERLAP ON EACH END
    - a. INSTALL CLAMP ON EACH END OF HOSE
    - b. INSTALL HOSE ON LINE
    - c. USE PROPER SCREWDRIVER
    - d. TURN SCREWS TO RIGHT (CLOCKWISE)
    - e. TIGHTEN TO SPECIFICATIONS

    NOTE: NEVER INSTALL RUBBER HOSE WITHIN FOUR INCHES OF EXHAUST SYSTEM

**8. MAKE VEHICLE READY**

1. CONNECT POSITIVE BATTERY CABLE
2. CONNECT BATTERY GROUND CABLE
    - a. USE BATTERY PLIERS
    - b. TURN NUTS TO RIGHT (CLOCKWISE)
    - c. TIGHTEN TO SPECIFICATION
3. REMOVE ALL TOOLS FROM VEHICLE
4. START ENGINE AND CHECK FOR FUEL AND OIL LEAKS

    NOTE: IF NO LEAKS APPEAR THE REPAIR IS SOUND

**9. CLEAN WORK STATION**

1. MOVE VEHICLE OUT OF WORK STATION
2. PARK VEHICLE IN PARKING AREA
3. CLEAN TOOLS AND RETURN TO STORAGE
4. PLACE TRASH IN COVERED TRASH CANS
5. SWEEP WORK STATION
6. PLACE RESIDUE IN TRASH CAN
7. RETURN CLEANING EQUIPMENT TO STORAGE

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO REPEAT STEPS OF THE TASK.
2. STUDENTS TO POINT OUT ITEMS OF SAFETY.
3. CAUTIONS AND PRECAUTIONS.
4. CHECK STUDENTS FOR KEY POINTS.
5. STUDENTS TO PRACTICE ON TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT STEPS FROM STAGE II.
2. EMPHASIZE SAFETY AND CAUTIONS IN STAGE II.
3. EMPHASIZE CHECKING STANDARDS FOR THE TASK.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN. PP. 137-144
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 267-271
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-3 TO 20-13

THE NEXT LESSON IS: VIII-C-19(S) "REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR"

VIII-C-18(J)

# JOB SHEET
# ON
# FUEL SYSTEM

**JOB:** REMOVE AND REPLACE FUEL PUMP

**MATERIALS:** CLEAN RAGS, GASKET SEALER, AND CLEANING SOLVENT

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS, SAFETY GOGGLES, DROP LIGHT, FENDER COVER, AND TUBE FLARING TOOLS

**GENERAL INSTRUCTIONS:** BEFORE DOING THIS JOB THE STUDENT SHOULD PASS TEST ON INFORMATION LESSON: VIII-C-22(I) AND SHOW DESIRE TO CONTINUE IN MANIPULATIVE SKILL PROCEDURE

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-C-17(TS) | PERFORM VEHICLE SAFETY |
| VIII-C-18(TS) | REPLACE FUEL FILTER |
| VIII-C-18a(TS) | REMOVE FUEL PUMP |
| VIII-C-18b(TS) | INSTALL FUEL PUMP |
| VIII-C-17f(TS) | MAKE VEHICLE READY |
| VIII-C-17g(TS) | CLEAN WORK STATION |
| VIII-C-18c(TS) | TEST FUEL PUMP |

**CHECK POINT:**

1. OBSERVATION OF PROTECTING PAINT ON VEHICLE
2. OBSERVATION OF SAFETY RULES, SHOP POLICIES, AND REGULATIONS
3. USE TOOLS IN PROFESSIONAL AND CRAFTSMANLIKE MANNER
4. TAKE MENTAL NOTES OF ALL NEW TASKS AT HAND

TASK SHEET VIII-C-18(TS)

**TASK:** REPLACE FUEL FILTER (IN LINE)

**JOB:** REMOVE AND REPLACE FUEL PUMP

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** HOSE CLAMP PLIERS, HAND TOOLS, SAFETY GOGGLES, DRIP PAN, SEAT AND FENDER COVER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. REMOVE FILTER | 1. POSITION DRIP PAN UNDER VEHICLE TO CATCH ANY SPILLED FUEL<br>2. REMOVE INLET AND OUTLET FUEL FILTER HOSE CLAMPS, WITH CORRECT TOOL<br>3. REMOVE IN LINE FUEL FILTERS AND HOSES FROM FUEL LINES<br>4. DISPOSE OF OLD PARTS IN SAFE CONTAINER |
| 4. INSTALL FILTER | 1. ASSEMBLE NEW FUEL FILTER WITH HOSE AND CLAMPS<br>2. INSTALL FILTER ASSEMBLY ONTO FUEL LINES<br>NOTE: USE CARE WHEN INSTALLING FILTER TO PREVENT ANY FOREIGN MATTER FROM ENTERING FUEL LINES<br>3. ADJUST AND TIGHTEN HOSE CLAMPS AND BRACKETS<br>4. START ENGINE AND RUN FOR A FEW MINUTES TO CHECK FOR FUEL LEAKS |
| 5. CLEAN WORK STATION | 1. AS PER VIII-C-1b(TS) |

## TASK SHEET

VIII-C-18a(TS)

**TASK:** REMOVE FUEL PUMP

**JOB:** REMOVE AND REPLACE FUEL PUMP

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, DROP LIGHT, FENDER COVER, SAFETY GOGGLES

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. DISCONNECT FUEL LINES | 1. RELEASE INLET LINE<br>a. USE CLAMP PLIERS<br>b. MOVE CLAMP TOWARD FUEL LINE<br>c. SEPARATE HOSE FROM FITTING<br>2. UNSCREW OUTLET LINE NUT<br>a. USE PROPER LINE WRENCHES<br>b. RETAIN FITTING WITH ONE WRENCH<br>c. TURN NUT TO LEFT (COUNTERCLOCKWISE) WITH ANOTHER LINE WRENCH |
| 2. DISCONNECT FUEL PUMP | 1. REMOVE FUEL PUMP ATTACHING BOLT<br>a. USE PROPER SOCKET, SHORT EXTENSION AND RATCHET<br>b. TURN BOLTS TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE BOLTS IN CONTAINER<br>2. CAREFULLY REMOVE PUMP AND GASKET<br>3. DISCARD GASKET |

TASK SHEET VIII-C-18b(TS)

**TASK:** INSTALL FUEL PUMP

**JOB:** REMOVE AND REPLACE FUEL PUMP

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, DROP LIGHT, FENDER COVER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE FUEL PUMP | 1. REMOVE ALL GASKET MATERIAL FROM PUMP AND MOUNTING PAD<br>a. SCRAPE OLD GASKET OFF PAD AND PUMP<br>b. WIPE CLEAN WITH RAG<br>2. APPLY OIL RESISTANT SEALER TO BOTH SIDES OF NEW GASKET<br>3. POSITION GASKET ON FUEL PUMP FLANGE |
| 2. POSITION FUEL PUMP | 1. HOLD FUEL PUMP IN POSITION AGAINST MOUNTING PAD<br>CAUTION: MAKE SURE ROCKER ARM OR ROD IS RIDING ON CAMSHAFT OR INTERMEDIATE SHAFT ECCENTRIC<br>2. PRESS FUEL PUMP TIGHT AGAINST PAD<br>3. INSTALL ATTACHING BOLTS<br>a. USE PROPER SOCKET AND TORQUE WRENCH<br>b. TURN BOLTS TO RIGHT (CLOCKWISE)<br>c. TIGHTEN TO SPECIFICATIONS |
| 3. CONNECT INLET FUEL HOSE | 1. INSTALL CLAMP ON HOSE<br>NOTE: USE NEW HOSE CLAMP<br>2. INSTALL HOSE ON FITTING<br>3. POSITION CLAMP ON HOSE TO SEAL HOSE TO FITTING |
| 4. CONNECT OUTLET LINE | 1. USE PROPER SIZE LINE WRENCHES<br>2. RETAIN FITTING WITH ONE WRENCH AND TURN NUT WITH ANOTHER<br>3. TURN NUT TO RIGHT (CLOCKWISE)<br>4. TIGHTEN TO SPECIFICATIONS<br>NOTE: IF HOSE IS USED AT FUEL PUMP CONNECTION, CRIMP RETAINING CLAMP |

| STEPS | KEY POINTS |
|---|---|
| | SECURELY |
| 5. REPAIR FUEL LINE | 1. CUT OUT DAMAGED SECTION OF FUEL LINE<br>a. USE TUBING CUTTER<br>b. REMOVE BURRS AND FLARE ENDS OF CUT LINE (READ DIRECTIONS)<br>c. USE TUBING FLARING TOOLS<br>d. FORM A DOUBLE FLARE ON EACH END OF FUEL LINE<br>2. INSTALL PROPER SIZE RUBBER HOSE ON FUEL LINE<br>NOTE: ALLOW TWO INCHES OVERLAP ON EACH LINE<br>a. INSTALL CLAMP ON EACH END OF RUBBER HOSE<br>b. INSTALL HOSE ON LINE<br>c. POSITION CLAMPS BEHIND FLANGE<br>d. TIGHTEN CLAMP SCREWS<br>e. USE PROPER SIZE SCREW DRIVER<br>f. TURN SCREWS TO RIGHT (CLOCKWISE)<br>g. TIGHTEN TO SPECIFICATIONS<br>CAUTION: NEVER INSTALL RUBBER HOSE WITHIN FOUR INCHES OF EXHAUST SYSTEM |

## TASK SHEET

VIII-C-18c(TS)

**TASK:** TEST FUEL PUMP

**JOB:** REMOVE AND REPLACE FUEL PUMP

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** TUBING WRENCHES, HOSE CLAMP PLIERS, FENDER COVER, SAFETY GOGGLES, DRIP PAN, VACUUM-PRESSURE GAGE WITH ADAPTERS, REMOTE STARTER SWITCH, AND SEAT COVERS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS IN PREVIOUS TASKS |
| 2. PREPARE VEHICLE | AS IN PREVIOUS TASKS |
| 3. PREPARE FOR TEST | 1. DISCONNECT FUEL INLET LINE AS PER VIII-C-1(TS)<br>2. PLUG FUEL HOSE TO PREVENT FUEL LEAKAGE<br>3. CONNECT VACUUM GAGE TO FUEL PUMP INLET TUBE |
| 4. TEST VACUUM | 1. START ENGINE AND LET IDLE<br>2. READ VACUUM GAGE<br>NOTE: MINIMUM READING SHOULD BE 10 INCHES OF VACUUM AT IDLE<br>3. STOP ENGINE<br>4. REMOVE GAGE CONNECTIONS<br>5. UNPLUG FUEL LINE AND INSTALL ON FUEL PUMP INLET TUBE |
| 5. TEST PRESSURE | 1. DISCONNECT FUEL LINE AT CARBURETOR AS PER VIII-C-1(TS)<br>2. CONNECT GAGE ADAPTER INTO FUEL LINE<br>3. START ENGINE AND LET IDLE<br>4. READ PRESSURE INDICATED ON GAGE<br>NOTE: READING SHOULD BE AS SHOWN IN SPECIFICATIONS FOR PUMP BEING TESTED AND REMAIN CONSTANT OR RETURN TO ZERO SLOWLY WHEN ENGINE IS STOPPED<br>5. STOP ENGINE<br>6. REMOVE GAGE CONNECTIONS |

| STEPS | KEY POINTS |
|---|---|
| | 7. INSTALL FUEL LINE TO CARBURETOR AND TIGHTEN |
| 6. CLEAN WORK STATION | 1. REMOVE TOOLS AND EQUIPMENT FROM VEHICLE |
| | 2. PARK VEHICLE |
| | 3. RETURN TOOLS AND EQUIPMENT TO STORAGE |
| | 4. CLEAN WORK AREA |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | CARBURETOR FUNDAMENTALS |
| AIM: | THE STUDENT WILL BE ABLE TO DEFINE COMPONENTS AND CIRCUITS IN A CARBURETOR AND DESCRIBE THEIR OPERATION. |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T, FIGS. 561-567<br>CARBURETOR<br>CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, CHS. 20 AND 26<br>AUTOMECHANICS, GLENN, CHS. 6 AND 11<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 20<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 245-254 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT SHOULD HAVE READ THE ASSIGNMENT FOR THIS LESSON. |

### I. PREPARATION (OF THE LEARNER - MOTIVATION)

ANYONE WHO HAS EVER FLOODED AN ENGINE SO THAT THE CAR WOULD NOT START KNOWS THAT IT CANNOT USE RAW LIQUID GASOLINE IN THE COMBUSTION CHAMBERS. GASOLINE MUST BE VAPORIZED AND MIXED WITH AIR IN ORDER TO BURN EFFECTIVELY. SEVERAL METHODS TO ACCOMPLISH THIS WERE TRIED WHEN ENGINES WERE FIRST BEING DEVELOPED. ONE INCLUDED DRAWING IN AIR OVER A PAN OF GASOLINE. THIS MIXTURE PROVED TO BE TOO LEAN, FOR GASOLINE WILL NOT EVAPORATE THAT QUICKLY UNLESS IT IS ATOMIZED. THE DEVICE THAT TURNS GASOLINE INTO VAPOR ALMOST INSTANTLY IS THE SUBJECT OF OUR LESSON TODAY: THE CARBURETOR.

### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE | 1. MIXES GASOLINE AND AIR DEPENDING ON ENGINE REQUIREMENTS<br>2. VARIES AMOUNTS OF EACH AUTOMATICALLY<br>a. RICHER MIXTURE OF GASOLINE NEEDED FOR:<br>(1) STARTING A COLD ENGINE<br>(2) FAST ACCELERATION |

- (3) IDLING
- b. LEANER MIXTURE WITH LESS FUEL FOR PART-THROTTLE OPERATION
- 3. CONTROLS SPEED AND POWER BY REGULATING AMOUNT DELIVERED TO CYLINDERS

B. PRINCIPLES OF OPERATIONS

1. DESIGN IS COMPLICATED BUT OPERATION RELATIVELY SIMPLE
2. ALL USE PRESSURE DIFFERENCES TO FUNCTION
   - a. DOWN STROKE OF PISTON CREATES VACUUM
   - b. AIR RUSHES INTO CYLINDER FROM INTAKE MANIFOLD
   - c. AIR TO MANIFOLD MUST COME THROUGH CARBURETOR
   - d. FUEL VAPORIZED AND BLENDED BY PASSING AIR
   - e. FUEL VAPORIZED AND BLENDED WITH AIR TO PRODUCE VOLATILE MIXTURE

C. CONSTRUCTION

1. FLOAT SYSTEM

SHOW: TRANSPARENCY FIG. 562

1. RESERVE BOWL LOCATED ON SIDE OF CARBURETOR
2. HOLDS GASOLINE SUPPLIED BY FUEL PUMP
3. FLOAT OPERATES NEEDLE VALVE TO CONTROL FUEL LEVEL
   - a. FLOAT IN UP POSITION WHEN BOWL IS FULL
   - b. NEEDLE SEATED IN VALVE STOPS INCOMING FUEL
   - c. FLOAT DROPS AS BOWL EMPTIES
   - d. NEEDLE UNSEATS ALLOWING MORE FUEL
4. LEVEL KEPT CONSTANT DURING ENGINE OPERATION
5. SOME HAVE DUAL FLOATS TO INSURE FUEL SUPPLY
6. BOWL VENTED TO INSIDE OF AIR HORN
7. MAY ALSO HAVE EXTERNAL VENT FOR IDLE
8. FUEL CIRCUITS CONNECT TO CARBURETOR BODY

2. AIR HORN

SHOW: TRANSPARENCY
FIG. 561

1. ALLOWS ENTRY OF ALL AIR GOING TO CYLINDERS
2. OPERATES ON VENTURI PRINCIPLE
    a. AIR RUSHES THROUGH TUBE OR AIR HORN
    b. RESTRICTION OF FLOW PROVIDED BY VENTURI
    c. AIR SPEEDS UP AFTER PASSING VENTURI
    d. DIFFERENCE IN SPEED CREATES A VACUUM
    e. FUEL SUCKED IN FROM RESERVE BOWL
3. AIR HORN EQUIPPED WITH "BUTTER-FLY" VALVES
    a. BELOW VENTURI IS THROTTLE OR VALVE
        (1) ROUND FLAT DISC MOUNTED ON A SHAFT
        (2) PIVOTS BY MEANS OF LINKAGE TO FOOT PEDAL
    b. CHOKE VALVE NEAR TOP ABOVE VENTURI
        (1) HAS SAME CONSTRUCTION AS THROTTLE VALVE
        (2) MAY BE CONTROLLED BY VACUUM, MANUAL, THERMOSTAT, OR ELECTRICITY
        (3) SOME HAVE TWO TYPES OF CONTROL

3. IDLE CIRCUIT

SHOW: TRANSPARENCY
FIG. 563

1. IDLE TUBE CARRIES FUEL TO BASE OF AIR HORN
2. IDLE JET OPENS BELOW THROTTLE VALVE
3. AIR BLEED HOLES ALLOW AIR IN CIRCUIT
4. IDLE JET REGULATED BY ADJUSTABLE NEEDLE VALVE

4. LOW SPEED

1. USES SAME FUEL TUBE AND PORT AS IDLE CIRCUIT
2. ALSO USES SAME AIR BLEED HOLES
3. LOW SPEED JET OPENS IMMEDIATELY ABOVE CLOSED POSITION OF THROTTLE VALVE

| | |
|---|---|
| | 4. OPENING THROTTLE SLIGHTLY ALLOWS BOTH JETS TO RELEASE FUEL AND AIR |
| 5. HIGH SPEED OR MAIN METERING SYSTEM | 1. USES THE MAIN METERING SYSTEM |
| | 2. NOZZLE EMPTIES FUEL INTO MIDDLE AIR HORN |
| | 3. AIR BLEED HOLE EMPTIES INTO MAIN DISCHARGE LINE |
| SHOW: TRANSPARENCY FIG. 564 | 4. MECHANICAL LINKAGE OR VACUUM OPERATES METERING ROD OR VALVE |
| | 5. LIMITS FUEL FLOW IN HIGH SPEED JET AT PART THROTTLE OPERATION |
| | 6. ANTISIPHON BLEED HOLE PREVENTS FUEL FLOW WHEN ENGINE STOPS |
| 6. POWER FUEL SYSTEM | 1. VACUUM PASSAGE CONNECTS MANIFOLD TO POWER VALVE CHAMBER IN MOST MODERN TYPES |
| | 2. PISTON OR DIAPHRAGM LOCATED IN CHAMBER |
| SHOW: TRANSPARENCY | 3. CALIBRATED SPRING UNDER PISTON |
| | 4. PISTON CONNECTS TO POWER VALVE |
| | 5. METERING ROD MAY REPLACE VALVE IN SOME |
| | 6. FEW DESIGNS ARE MECHANICAL INSTEAD OF VACUUM |
| 7. ACCELERATOR PUMP SYSTEM | 1. OPERATED BY LINKAGE CONNECTED TO THROTTLE |
| | 2. HAS SPRING LOADED PLUNGER OR DIAPHRAGM |
| | 3. PUMP CYLINDER LINE EMPTIES INTO AIR HORN |
| | 4. INLET AND DISCHARGE VALVES CONTROL FUEL MOVEMENT |
| D. CIRCUIT OPERATION | 1. FUEL REQUIREMENTS VARY WITH CONDITIONS |
| | 2. CIRCUITS AND SYSTEMS COMPENSATE FOR DIFFERENCES |
| 1. IDLE CIRCUIT | 1. THROTTLE VALVE CLOSED CUTTING OFF AIR THROUGH HORN |
| | 2. NO VACUUM DEVELOPED IN VENTURI |
| | 3. HIGH VACUUM BELOW THROTTLE DUE TO INTAKE MANIFOLD |
| | 4. FUEL - AIR MIXTURE FROM IDLE CIRCUIT DRAWN OUT OF JET BELOW THROTTLE |

   5. HIGH FUEL TO AIR RATIO (RICH MIXTURE) NEEDED AT IDLE

2. LOW SPEED CIRCUIT
   1. OPENING THROTTLE PLATE SLIGHTLY MOVES ITS EDGE ABOVE LOW SPEED PORT
   2. BOTH IDLE AND LOW SPEED PORTS FEED FUEL
   3. AIR PASSING THROTTLE MIXED WITH FUEL
   4. FUEL TO AIR RATIO LESS (LEANER) THAN AT IDLE
3. HIGH SPEED OR MAIN METERING SYSTEM
   1. THROTTLE VALVE OPEN WIDE ALLOWING AIR PASSAGE
   2. FUEL FED INTO VENTURI THROUGH MAIN METERING SYSTEM FROM CARBURETOR BOWL
   3. IDLE AND LOW SPEED CIRCUITS CEASE TO FUNCTION
   4. FUEL- AIR RATIO ABOUT SAME AS LOW SPEED CIRCUIT EXCEPT AT FULL THROTTLE
   5. FULL THROTTLE OPERATION REQUIRES RICHER MIXTURE
   6. EXTRA FUEL SUPPLIED BY POWER FUEL SYSTEM
4. POWER FUEL SYSTEM
   1. MOST ARE VACUUM OPERATED BY INTAKE MANIFOLD
   2. COMPOSED OF DIAPHRAGM OR PISTON LINKED TO METERING ROD OR VALVE AS PREVIOUSLY DESCRIBED
   3. MANIFOLD VACUUM HOLDS PISTON OR DIAPHRAGM IN PLACE AT PART THROTTLE AND KEEPS VALVE CLOSED
   4. VACUUM REDUCED WHEN THROTTLE OPENED WIDE
   5. SPRING NOW PUSHES UP PISTON OR DIAPHRAGM
   6. MOVEMENT UNSEATS METERING ROD OR VALVE
   7. FUEL GOES THROUGH JET INTO MAIN DISCHARGE LINE
5. ACCELERATOR PUMP
   1. QUICK OPENING OF THROTTLE ALLOWS EXCESS OF AIR
   2. FUEL TO AIR RATIO GREATLY REDUCED

3. ACCELERATOR PUMP PREVENTS THIS
    a. PUMP PLUNGER FORCED DOWN BY THROTTLE LINKAGE
    b. PUMPS FUEL OUT JET INTO AIR HORN
    c. PROPER FUEL - AIR RATIO MAINTAINED
4. GIVES HIGH SPEED CIRCUIT TIME TO CATCH UP
5. SPRING MAINTAINS PUMP PRESSURE SEVERAL SECONDS
6. SECOND SPRING RETURNS PLUNGER TO NORMAL

6. CHOKE

1. FUEL VAPORIZED SLOWLY BY COLD ENGINE
2. EXCESS FUEL NEEDED FOR STARTING
3. CHOKE VALVE CAUSES HIGH FUEL TO AIR RATIO
    a. VALVE CLOSES AT TOP OF AIR HORN
    b. INTAKE MANIFOLD PRODUCES HIGH VACUUM INSIDE
    c. FUEL IS SUCKED OUT NOZZLE OF MAIN DISCHARGE LINE
    d. VALVE OPENS AFTER ENGINE STARTS
4. PULL ROD CONNECTED TO DASH OPERATES CHOKE ON OLDER MODELS
5. MOST MODERN VEHICLES HAVE AUTOMATIC CHOKE
6. OPERATE ON TEMPERATURE AND VACUUM
7. BOTH UNITS CONNECT TO CHOKE VALVE
    a. THERMOSTATIC WIRE COIL CLOSES VALVE WHEN COLD
    b. HEAT CAUSES COIL TO UNWIND OPENING VALVE
    c. INTAKE MANIFOLD PRODUCES VACUUM DURING CRANKING
    d. VACUUM PISTON IS PULLED OUT OPENING VALVE SLIGHTLY
    e. CHOKE VALVE CONTROLLED BY VACUUM PISTON DURING ENGINE WARM-UP
    f. HEAT OF RUNNING ENGINE CAUSES

## II. PRESENTATION (CON'T)

THERMOSTATIC COIL TO TAKE OVER CHOKE VALVE OPERATION

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATION OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK QUESTIONS TO STIMULATE DISCUSSION AND CHECK COMPREHENSION OF THE MATERIAL PRESENTED.

EXAMPLE: WHY IS A RICH FUEL MIXTURE NEEDED TO START A COLD ENGINE?

ANSWER: GASOLINE VAPORIZES SLOWLY WHEN COLD, SO MORE IS REQUIRED TO GET THE PROPER FUEL-AIR RATIO.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

QUESTIONS: SIMPLE RECALL

| | | |
|---|---|---|
| 1. | THE TERM "RICH MIXTURE" MEANS A HIGHER _____ TO _____ RATIO. | FUEL<br>AIR |
| 2. | CARBURETORS USE ___ DIFFERENCES IN OPERATION. | PRESSURE |
| 3. | GASOLINE MUST BE _____ AND BLENDED WITH AIR IN ORDER TO BECOME A _____ MIXTURE. | VAPORIZED<br>VOLATILE |
| 4. | FUEL LEVEL IN THE RESERVE BOWL IS CONTROLLED BY A _____ AND _____. | FLOAT<br>NEEDLE VALVE |
| 5. | AN AIR HORN HAS A RESTRICTION CALLED A _____. | VENTURI |
| 6. | THE PURPOSE OF THE RESTRICTION IS TO INCREASE _____. | VACUUM |
| 7. | A DESCRIPTIVE NAME FOR THE VALVES IN THE AIR HORN IS _____. | BUTTERFLY |
| 8. | THE VALVE IN THE TOP OF THE AIR HORN IS THE _____ VALVE. | CHOKE |
| 9. | WHEN THE LOW SPEED CIRCUIT IS OPERATING, THE FUEL TO AIR RATIO IS _____ THAN AT IDLE. | LEANER |
| 10. | AUTOMATIC CHOKES WORK ON _____ AND _____. | TEMPERATURE<br>VACUUM |

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAYBE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE SOLE PURPOSE OF A CARBURETOR IS TO SUPPLY THE ENGINE WITH A CORRECT MIXTURE OF FUEL AND AIR DEPENDING ON CONDITIONS AND DEMANDS OF THE DRIVER.

SOMEWHAT COMPLICATED IN APPEARANCE, CARBURETORS USE DIFFERENCES IN PRESSURE FOR RELATIVELY SIMPLE OPERATION. AIR FLOW CONTROLLED BY VALVES CREATES VACUUM IN DIFFERENT AREAS OF THE AIR HORN. THIS IN TURN CALLS VARIOUS CIRCUITS INTO PLAY.

A RESERVE BOWL HOLDS GASOLINE TO BE USED BY THE CIRCUITS. CONSTANT FUEL LEVEL IS MAINTAINED BY A FLOAT AND NEEDLE VALVE SYSTEM.

ALL AIR ENTERING THE CYLINDERS MUST PASS THROUGH THE AIR HORN OF THE CARBURETOR. A RESTRICTION CALLED A VENTURI CREATES A VACUUM, AND CONTROL OF THE ENGINE SPEED IS ACCOMPLISHED BY LINKAGE WHICH ALLOWS THE DRIVER TO ADJUST THE AREA OF VACUUM IN THE AIR HORN.

THE THROTTLE VALVE IS CLOSED AT IDLE. THE INTAKE MANIFOLD CREATES A VACUUM BELOW IT, AND FUEL IS SUCKED OUT OF THE IDLE PORT. A LOW SPEED CIRCUIT PORT IS LOCATED IMMEDIATELY ABOVE THE CLOSED POSITION OF THE THROTTLE, AND OPENING IT SLIGHTLY CAUSES FUEL TO BE SUCKED OUT. BOTH IDLE AND LOW SPEED CIRCUITS FEED FUEL INTO THE CARBURETOR DURING LOW SPEED OPERATION.

THE HIGH SPEED CIRCUIT, POWER FUEL SYSTEM, AND ACCELERATOR PUMP MAINTAIN FUEL CONCENTRATION AT THE NECESSARY LEVELS EVEN THOUGH AIR HORN VACUUM CHANGES.

CHOKE VALVES WERE ONCE MANUALLY OPERATED, BUT MOST MODERN VEHICLES HAVE AN AUTOMATIC CHOKING DEVICE THAT OPERATES ON TEMPERATURE AND VACUUM TO INSURE THE CORRECT FUEL-AIR RATIO.

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SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE MECHANICS, CROUSE, CHS. 20 AND 26

THE NEXT LESSON IS: VIII-C-24(I) "CARBURETOR TYPES AND SERVICE"

VIII-C-24(I)

# INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

**SUBJECT:** CARBURETOR TYPES AND SERVICE

**AIM:** THE STUDENT WILL BE ABLE TO COMPARE DIFFERENT TYPES OF CARBURETORS AND DESCRIBE SERVICE PROCEDURES.

**TEACHING AIDS:** CARBURETORS, CHALKBOARD

**MATERIALS:** CHALK

**REFERENCES:** AUTOMOTIVE MECHANICS, CROUSE, CHS. 9 AND 20
AUTOMECHANICS, GLENN, CHS. 6 AND 11
AUTO SERVICE AND REPAIR, STOCKEL, CH. 20
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 245-254

**PREREQUISITE EXPERIENCE OF THE LEARNER:** THE STUDENT SHOULD HAVE SATISFACTORILY COMPLETED THE LESSON ON CARBURETOR FUNDAMENTALS.

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN THE LAST LESSON WE LEARNED HOW A RATHER COMPLICATED DEVICE, THE CARBURETOR, USES PRESSURE DIFFERENCES IN MIXING FUEL AND AIR TO MEET ENERGY REQUIREMENTS. THE IMPORTANCE OF THE CARBURETOR CANNOT BE STRESSED TOO MUCH, FOR WE KNOW THAT FUEL, COMPRESSION, AND IGNITION ARE WHAT MAKE AN ENGINE RUN. TODAY WE WILL SEE SOME DIFFERENT TYPES OF CARBURETORS AND LEARN SOME THINGS ABOUT SERVICE CONSIDERATIONS.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. TYPES OF CARBURETORS | 1. THERE IS MUCH VARIATION IN CARBURETOR DESIGN<br>2. VARY WITH MANUFACTURERS, MODELS, AND ENGINES<br>3. SOME HAVE SPECIAL DEVICES<br>a. SPARK ADVANCE VACUUM CIRCUITS<br>b. TOP ENGINE SPEED CONTROLS OR GOVERNORS<br>c. THROTTLE MODULATOR TO CLOSE VALVE COMPLETELY WHEN IGNITION IS OFF |

- d. CARS WITH AUTOMATIC TRANSMISSION MAY HAVE:
  - (1) ELECTRIC KICK DOWN SWITCH
  - (2) THROTTLE RETURN CHECK ON DASHPOT TO SLOW DOWN THE CLOSING OF THROTTLE

B. CARBURETOR BARRELS

1. SINGLE BARREL MOST COMMON ON SMALL ENGINES
   - a. CONSTRUCTION IS AS DESCRIBED IN PREVIOUS LESSON BUT WITH VARIATIONS
   - b. IS LIMITED IN FUEL AND AIR OUTPUT
2. DUAL CARBURETOR COMPARABLE TO TWO SINGLES
   - a. FUEL - AIR REQUIREMENTS FOR HALF THE CYLINDERS HANDLED BY EACH BARREL
   - b. COMPLETE CIRCUITS IN EACH BARREL
   - c. LINKAGE ALLOWS VALVES TO WORK TOGETHER
3. FOUR-BARREL COMPARABLE TO TWO DUALS IN A SINGLE UNIT
   - a. PRIMARY SECTION CONTAINS TWO BARRELS
     - (1) HAS IDLE, LOW-SPEED, HIGH SPEED, ACCELERATOR, AND POWER SYSTEM
     - (2) ALSO HAS AUTOMATIC CHOKE
   - b. SECONDARY SECTION ALSO HAS TWO BARRELS
     - (1) CONTAINS HIGH SPEED CIRCUITS
     - (2) ASSISTS PRIMARY BY CUTTING IN AT SPECIFIED SPEED OR ENGINE LOAD
     - (3) SEPARATE THROTTLES OPEN BY DELAYED ACTION LINKAGE

C. COMBINATIONS

1. COMBINATIONS MAY BE USED ON HIGH PERFORMANCE ENGINES
2. REQUIRES SPECIALLY CONSTRUCTED INTAKE MANIFOLD
3. DUAL FOUR-BARREL CARBURETORS

   - a. FRONT CARBURETOR ASSISTS ONE IN REAR
   - b. FRONT ONE BEGINS TO OPEN WHEN REAR IS HALF OPEN
   - c. BOTH OPEN AT FULL THROTTLE
   - d. BASIC ADJUSTMENTS SAME AS FOR SINGLE
4. THREE DUAL CARBURETORS
   - a. CENTRAL CARBURETOR CONTAINS ALL CIRCUITS
   - b. FRONT AND REAR CONTAIN ONLY FLOAT, ACCELERATING, AND MAIN METERING CIRCUITS

D. LINKAGE

1. THROTTLE COMPLETELY OPEN WHEN FOOT PEDAL DEPRESSED
2. THROTTLE COMPLETELY CLOSED WHEN PEDAL RELEASES
3. SOME HAVE ADJUSTABLE LINKAGE TO ACCELERATOR PUMP
4. CLIPS, PINS, AND ADJUSTABLE JOINTS CONNECT LINKAGE COMPONENTS

E. GASKET

1. NEW GASKETS ALWAYS USED IN ASSEMBLING CARBURETOR
2. GASKET BETWEEN CARBURETOR AND INTAKE MANIFOLD SHOULD BE IN PERFECT CONDITION OR REPLACED
3. MAY BE 1/2 INCH THICK TO PREVENT VAPOR LOCK

F. CAUSES OF MALFUNCTIONS

1. MOST CARBURETOR MALFUNCTIONS ARE DUE TO DIRT
   - a. PLUGS AIR AND FUEL CIRCUITS
   - b. CAUSES EXCESSIVE WEAR
2. OTHER MALFUNCTIONS DUE TO GUM AND RESIDUE CAUSING MOVING PARTS TO STICK
3. DEFECTIVE OR WORN PARTS
4. INCORRECT ADJUSTMENTS OF LINKAGE
5. INCORRECT SETTING OF AIR AND FUEL ADJUSTMENTS

G. ADJUSTMENTS

1. MANUFACTURER'S SHOP MANUAL GIVES SPECIFICATIONS ON INDIVIDUAL CARBURETORS

2. IDLE MIXTURE AND SPEED ADJUSTMENTS
    a. DETERMINE FUEL-AIR RATIO AND SPEED
    b. ARE MADE AT SAME TIME
    c. SPEED ADJUSTED TO GIVE RPM
    d. FUEL-AIR RATIO THEN ADJUSTED FOR SMOOTHNESS
3. LINKAGE ROD ALLOWS ACCELERATOR PUMP ADJUSTMENT
4. FLOAT, METERING ROD, AND OTHER PARTS ADJUSTABLE ON SOME

H. CLEANING SOLVENTS

1. GASOLINE OR DENATURED ALCOHOL ARE USED

CAUTION: MOST CLEANING SOLVENTS ARE HIGHLY FLAMMABLE. HANDLE THEM WITH CARE

I. TESTERS

1. COMBUSTION ANALYZER CHECKS PERCENTAGE OF UNBURNED FUEL IN EXHAUST GAS
2. TACHOMETER GIVES ENGINE RPM FOR ADJUSTMENT OF CORRECT IDLE SPEED
3. VACUUM GAUGE USED TO ADJUST IDLE MIXTURE

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK QUESTIONS TO STIMULATE DISCUSSION AND CHECK COMPREHENSION OF INFORMATION PRESENTED IN THE LESSON.

EXAMPLE: WHAT IS THE ADVANTAGE OF HAVING MORE THAN ONE CARBURETOR ON AN ENGINE?

ANSWER: THEY INCREASE PERFORMANCE BY GIVING FASTER ACCELERATION AND HIGHER TOP SPEED.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE

1. GOVERNORS ARE DEVICES USED TO ADVANCE THE SPARK. F

## IV. VERIFICATION (CON'T)

2. A THROTTLE MODULATOR CLOSES THE THROTTLE WHEN THE IGNITION IS TURNED OFF. T

3. CARS WITH STANDARD TRANSMISSIONS MAY HAVE A KICKDOWN SWITCH ON THE CARBURETOR. F

4. SMALLER ENGINES REQUIRE LESS CARBURETION. T

5. FOUR-BARREL CARBURETORS HAVE A PRIMARY AND A SECONDARY SECTION. T

6. DUAL CARBURETORS WHEN SINGLE MOUNTED CONTAIN COMPLETE CIRCUITS IN EACH BARREL. T

7. ON DUAL FOUR-BARREL COMBINATIONS, THE REAR CARBURETOR ASSISTS THE ONE IN FRONT. F

8. ON THREE DUAL CARBURETOR COMBINATIONS, THE CENTRAL ONE CONTAINS ALL THE CIRCUITS. T

9. THE CARBURETORS ALL CONTAIN FLOAT CIRCUITS IN THREE CARBURETOR COMBINATIONS. T

10. THE PRIMARY CAUSE OF CARBURETOR MALFUNCTION IS INCORRECT AIR AND FUEL ADJUSTMENTS. F

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

AN ESTIMATED 500 DIFFERENT CARBURETORS HAVE BEEN MANUFACTURED IN THE UNITED STATES IN THE LAST 10 YEARS. THEY VARY WITH DESIGNER, ENGINE TYPE, DUTY PERFORMED, ETC., AND SOME ARE EQUIPPED WITH SPECIAL DEVICES.

THE SINGLE BARREL CARBURETOR IS PROBABLY THE MOST COMMON ON SMALL ENGINES, BUT MORE POWERFUL ENGINES MAY HAVE DUAL OR FOUR-BARREL CARBURETORS FOR BETTER FUEL AND AIR DISTRIBUTION.

CARBURETOR REQUIREMENTS FOR HIGH PERFORMANCE ENGINES ARE MET BY SPECIAL MANIFOLDS WITH COMBINATIONS OF CARBURETORS. THEY ARE USUALLY A PAIR OF FOUR-BARRELS, THREE TWO-BARRELS, OR A SINGLE BARREL FOR EACH CYLINDER.

DIRT, WEAR, AND POOR ADJUSTMENTS CAUSE MOST CARBURETOR MALFUNCTIONS. THE MANUFACTURER'S SHOP MANUAL SHOULD ALWAYS BE CONSULTED, AND A VACUUM GAUGE, TACHOMETER, AND COMBUSTION ANALYZER SHOULD BE USED IN CARBURETOR REPAIR AND ADJUSTMENT.

SUGGESTED READING FOR STUDENTS:

AUTO SERVICE AND REPAIR, STOCKEL, CH. 33

THE NEXT LESSON IS: VIII-B-6(I), "CRANKCASE VENTILATION"

THE NEXT LESSON IN THIS SERIES IS: VIII-C-27(I), "HEAT RISER"

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

VIII-C-19(S)

| | |
|---|---|
| TASK: | REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR |
| AIM: | STUDENT WILL BE ABLE TO PROPERLY REMOVE AND DISASSEMBLE A ONE BARREL CARBURETOR. THE STUDENT WILL LEARN THIS FIRST TASK AS A PART OF MAJOR TUNE-UP |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SAFETY GOGGLES, FLAT DRAIN PAN, FENDER COVERS, SEAT COVER, AND PARTS PAN |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | TRANSPARENCIES: I ED. II 7T, FIGS. 561-567 |
| REFERENCES: | MANUFACTURER'S SERVICE MANUAL OF CARBURETOR AT HAND<br>AUTOMECHANICS, GLENN, PP. 144-168<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266<br>AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT MUST HAVE PASSED SATISFACTORILY THE TESTS ON THE INFORMATION LESSONS AND PROVE A DESIRE TO ADVANCE TO MANIPULATIVE SKILL LESSON. |
| CHECKING STANDARDS: | 1. SELECT PROPER TOOLS AND EQUIPMENT<br>2. PROPER USE OF TOOLS AND EQUIPMENT<br>3. FOLLOW STEPS AND KEY POINTS<br>4. SAFETY PROCEDURES AND SHOP PRACTICES<br>5. EFFECTIVE EFFICIENT SERVICE OF REPAIRED VEHICLE<br>6. WORK IN A CRAFTSMANLIKE MANNER |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

A CARBURETOR IS THE PART THAT SUPPLIES AND METERS THE GASOLINE FOR THE ENGINE. THE CARBURETOR ALSO MIXES THE GASOLINE WITH THE AIR THAT ENTERS THE MANIFOLD. THE REASON FOR OVERHAULING A CARBURETOR IS TO KEEP THE FUEL-AIR RATIO AT PROPER SPECIFICATIONS. THIS WILL GIVE BEST PERFORMANCE AND ECONOMY. THIS LESSON WILL DEMONSTRATE THE CORRECT PROCEDURE IN THE REMOVAL AND DISASSEMBLY OF A ONE BARREL CARBURETOR. THE TEST WILL BE THE STUDENT'S ABILITY TO REMOVE AND DISASSEMBLE THE CARBURETOR CORRECTLY.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. PREPARE VEHICLE | 1. AS IN PREVIOUS LESSONS |
| 2. REMOVE AIR CLEANER | 1. AS IN PREVIOUS LESSONS |
| 3. REMOVE CARBURETOR | CAUTION: DO NOT ATTEMPT TO REMOVE CARBURETOR FROM ENGINE OF A VEHICLE THAT HAS JUST BEEN ROAD TESTED. ALLOW ENGINE TO COOL SUFFICIENTLY TO PREVENT ACCIDENTAL FUEL IGNITION OR PERSONAL INJURY |
| | 1. REMOVE THE GASOLINE TANK CAP TO RELIEVE POSSIBLE PRESSURE |
| | 2. PLACE A CONTAINER UNDER FUEL INLET FITTING TO CATCH ANY FUEL THAT MAY BE TRAPPED IN FUEL LINE |
| | 3. DISCONNECT FUEL LINE |
| | 4. USE TWO WRENCHES TO AVOID TWISTING LINE |
| | 5. DISCONNECT THROTTLE AND CHOKE LINKAGE |
| | 6. DISCONNECT ALL VACUUM LINES |
| | 7. REMOVE CARBURETOR BASE NUTS OR BOLTS<br>NOTE: STORE NUTS OR BOLTS IN CONTAINER |
| | 8. CAREFULLY REMOVE CARBURETOR FROM ENGINE<br>CAUTION: HOLD CARBURETOR LEVEL TO AVOID SPILLING FUEL FROM FUEL BOWL |
| | 9. PLACE CARBURETOR ON REPAIR STAND |
| 4. DISASSEMBLE CARBURETOR | 1. REMOVE BOWL VENT ASSEMBLY<br>NOTE: PLACE ALL PARTS (EXCEPT DIAPHRAGMS) INTO CARBURETOR CLEANER TRAY |
| | 2. REMOVE FAST IDLE CAM RETAINING CLIP, IDLE CAM, AND LINK |
| | 3. DISCONNECT LINK |
| | 4. REMOVE CHOKE VACUUM DIAPHRAGM, LINK, AND BRACKET ASSEMBLY |
| | 5. DISENGAGE LINK FROM SLOT IN CHOKE LEVER<br>NOTE: PLACE DIAPHRAGM TO ONE SIDE TO BE CLEANED AS SPECIAL ITEM |

6. REMOVE POSITIVE THROTTLE RETURN SPRING AND PUMP ROCKER ARM AND LINKAGE ASSEMBLY
   CAUTION: BE SURE TO RELEASE SPRING TENSION BEFORE REMOVING RETAINING NUT AND LOCK WASHER
7. REMOVE BOWL COVER SCREWS AND LIFT BOWL COVER STRAIGHT UP UNTIL VACUUM PISTON STEM, ACCELERATOR PUMP, AND MAIN WELL TUBE ARE CLEAR OF MAIN BODY
   NOTE: SEPARATE BOWL COVER FROM CARBURETOR BODY BY TAPPING WITH A PLASTIC HAMMER OR HANDLE OF A SCREWDRIVER
   CAUTION: NEVER PRY COVER OFF WITH SCREWDRIVER BLADE
8. REMOVE BOWL COVER GASKET
   NOTE: IF ANY GASKET MATERIAL IS REMAINING ON EITHER SURFACE, REMOVE WITH A SUITABLE CLEANER
   CAUTION: DO NOT USE A METAL SCRAPER SUCH AS A CARBON SCRAPER OR SCREWDRIVER ON EITHER BOWL OR COVER SURFACE. A NYLON OR HARD PLASTIC MATERIAL MAY BE USED AS A SUITABLE SCRAPER

5. DISASSEMBLE CARBURETOR COVER

1. REMOVE ACCELERATING PUMP OPERATING ROD RETAINER SCREW AND RETAINER
2. ROTATE PUMP OPERATING ROD
3. DISCONNECT PUMP DRIVE SPRING
4. REMOVE ACCELERATING PUMP ASSEMBLY
   NOTE: SET PUMP STEM AND CUP ASIDE DO NOT IMMERSE IN CLEANER
5. ROTATE PUMP OPERATING ROD
6. REMOVE PUMP OPERATING ROD FROM BOWL COVER
7. REMOVE PUMP OPERATING ROD GROMMET
   NOTE: THE POWER PISTON ASSEMBLY RETAINING RING IS STAKED IN POSITION, CARE MUST BE TAKEN IN REMOVAL

8. REMOVE STAKING WITH SUITABLE SHARP TOOL
9. REMOVE VACUUM PISTON FROM BOWL COVER
10. DEPRESS PISTON AND ALLOW IT TO SNAP UP AGAINST RETAINING RING

NOTE: THIS COMPLETES DISASSEMBLY OF BOWL COVER. MAIN WELL TUBE CANNOT BE REMOVED AND MUST BE CAREFULLY BLOWN OUT FROM BOTH INSIDE AND OUTSIDE OF COVER

6. DISASSEMBLE CARBURETOR MAIN BODY

1. REMOVE FUEL INLET FITTING VALVE ASSEMBLY FROM MAIN BODY
2. SEPARATE THE GASKETS FROM THE PARTS
3. REMOVE THE SPRING FLOAT SHAFT RETAINER, FLOAT SHAFT, AND FLOAT ASSEMBLY
4. TURN CARBURETOR BODY UPSIDE DOWN AND REMOVE PUMP DISCHARGE CHECK BALL AND WEIGHT
5. REMOVE THE MAIN JET
    a. USE THE PROPER SIZE SCREWDRIVER
    b. TURN JET TO LEFT (COUNTERCLOCKWISE)

NOTE: BE SURE SCREWDRIVER HAS GOOD SQUARE BLADE

CAUTION: CAREFULLY DEPRESS POWER VALVE NEEDLE WITH PROPER SCREWDRIVER UNTIL SCREWDRIVER BLADE IS SQUARELY SEATED IN SLOT ON TOP OF VALVE

6. REMOVE VALVE

NOTE: THE POWER VALVE ASSEMBLY CONSISTS OF THE SEAT, NEEDLE, AND SPRING. ALL OF THESE COMPONENTS OF THE SERVICE POWER VALVE SHOULD BE USED IF REPLACEMENT IS REQUIRED

7. REMOVE THROTTLE BODY SCREWS FROM MAIN BODY
8. SEPARATE MAIN BODY FROM THROTTLE BODY
9. DISCARD OLD GASKET
10. REMOVE CURB IDLE SCREW

11. TURN THE LIMITER CAP TO ITS LEANEST POSITION AND REMOVE CAP
NOTE: GENTLY TURN THE IDLE MIXTURE SCREW CLOCKWISE UNTIL IT SEATS
NOTE: RECORD STARTING POSITION AND EXACT NUMBER OF TURNS REQUIRED TO SEAT SCREW. THIS IS NECESSARY TO RE-INSTALL IT IN SAME POSITION AFTER REMOVAL AND CLEANING

| | |
|---|---|
| 7. CLEAN WORK STATION | 1. PLACE ALL PARTS IN PROPER ORDER IN PREPARATION FOR CLEANING<br>2. CLEAN TOOLS<br>3. RETURN TOOLS TO STORAGE AREA<br>4. CLEAN BENCH AND WORK AREA<br>5. RETURN FENDER COVERS AND SEAT COVERS TO PROPER STORAGE AREA<br>6. PREPARE FOR NEXT LESSON |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. FURNISH STUDENTS WITH JOB AND TASK SHEETS.

2. STUDENT TO PRACTICE ON TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. CORRECT REMOVAL OF CARBURETOR.

2. CORRECT DISASSEMBLY OF CARBURETOR.

3. ARRANGEMENT OF PARTS IN PREPARATION FOR CLEANING PARTS.

4. OBSERVANCE OF GOOD WORK SAFETY HABITS.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY WORK HABITS.

2. POINT OUT STEP BY STEP PROCEDURE FOR CARBURETOR REMOVAL AND DISASSEMBLY.

3. REVIEW TASK OF REMOVAL AND DISASSEMBLY OF CARBURETOR.

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SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN, PP. 144-168
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29

THE NEXT LESSON IS: VIII-C-20(S), "CLEAN, INSPECT, REPAIR, OR REPLACE PARTS OF ONE BARREL CARBURETOR"

VIII-C-19(J)

# JOB SHEET
# ON
# FUEL SYSTEM

| | | |
|---|---|---|
| JOB: | REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR | |
| MATERIALS: | CLEAN RAGS | |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, FENDER COVERS, SEAT COVERS, DROP LIGHT, AND SPECIAL CARBURETOR TOOLS | |
| GENERAL INSTRUCTIONS: | SAFETY GOGGLES OR GLASSES MUST BE WORN AT ALL TIMES TO PROTECT THE EYES FROM GASOLINE AND DIRT | |
| PROCEDURE AND/OR TASKS: | VIII-C-19(TS) | REMOVE ONE BARREL CARBURETOR FROM VEHICLE |
| | VIII-C-19a(TS) | DISASSEMBLE THROTTLE BODY FLANGE ASSEMBLY |
| | VIII-C-19b(TS) | DISASSEMBLE ONE BARREL CARBURETOR BOWL COVER |
| | VIII-C-19c(TS) | DISASSEMBLE ONE BARREL CARBURETOR MAIN BODY |

CHECK POINTS:

1. HAVE INSTRUCTOR CHECK FOR PROPER DISASSEMBLY
2. CHECK CARBURETOR FOR TYPE METAL PRIOR TO SELECTION OF CARBURETOR CLEANER
   CAUTION: CERTAIN CLEANERS CAUSE A CHEMICAL REACTION TO THE METAL
3. CHECK WITH INSTRUCTOR BEFORE PROCEEDING TO CLEANING AND INSPECTION

# TASK SHEET

VIII-C-19(TS)

TASK: REMOVE ONE BARREL CARBURETOR FROM VEHICLE

JOB: REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, FENDER COVERS, SEAT COVER, DROP LIGHT, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE VEHICLE | CAUTION: DO NOT ATTEMPT TO REMOVE CARBURETOR FROM ENGINE OF VEHICLE THAT HAS JUST BEEN ROAD TESTED. ALLOW ENGINE TO COOL SUFFICIENTLY TO PREVENT ACCIDENTAL FUEL IGNITION OR PERSONAL INJURY<br>1. REMOVE GASOLINE TANK CAP TO RELIEVE POSSIBLE PRESSURE<br>2. OPEN HOOD<br>3. INSTALL FENDER COVERS |
| 2. REMOVE AIR CLEANER | 1. REFER TO AS IN PREVIOUS TASK |
| 3. DISCONNECT CARBURETOR | 1. PLACE CONTAINER UNDER INLET FUEL FITTING<br>2. LOOSEN INLET FUEL LINE NUT WITH TWO WRENCHES<br>CAUTION: USE TWO TUBING NUT WRENCHES TO AVOID DAMAGE TO NUTS OR TWISTING FUEL LINE<br>3. DISPOSE OF GASOLINE FROM LINE<br>4. DISCONNECT THROTTLE AND CHOKE LINKAGE<br>a. USE THIN NOSE PLIERS<br>b. PULL OFF RETAINERS<br>c. PLACE RETAINERS IN CONTAINER<br>5. REMOVE CARBURETOR BASE NUTS OR BOLTS<br>a. USE PROPER WRENCH<br>b. TURN NUTS OR BOLTS TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE NUTS OR BOLTS IN CONTAINER |

| STEPS | KEY POINTS |
|---|---|
| | 6. CAREFULLY LIFT CARBURETOR FROM ENGINE<br>CAUTION: HOLD CARBURETOR LEVEL TO AVOID SPILLING FUEL FROM FUEL BOWL |
| | 7. PLACE CARBURETOR ON REPAIR STAND |

# TASK SHEET

VIII-C-19a(TS)

TASK: DISASSEMBLE THROTTLE BODY FLANGE ASSEMBLY

JOB: REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND, TRAY FOR PARTS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE EXTERNAL PARTS | NOTE: PLACE ALL PARTS (EXCEPT DIAPHRAGMS) IN CARBURETOR PARTS CLEANER TRAY<br>1. REMOVE BOWL VENT ASSEMBLY<br>a. USE PROPER SCREWDRIVER<br>b. TURN SCREW TO LEFT (COUNTER-CLOCKWISE)<br>c. PLACE SCREW AND ASSEMBLY IN CONTAINER<br>2. REMOVE FAST IDLE CAM RETAINING CLIP, IDLE CAM, AND LINK<br>a. PRY CLIP OFF WITH PROPER SIZE SCREWDRIVER<br>b. LIFT OFF CAM AND LINKS<br>c. PLACE IN CONTAINER<br>3. REMOVE CHOKE DIAPHRAGM, LINK, AND BRACKET ASSEMBLY<br>a. USE PROPER SIZE SCREWDRIVER<br>b. TURN SCREWS TO LEFT (COUNTER-CLOCKWISE)<br>c. DISCONNECT LINK<br>NOTE: PLACE DIAPHRAGM TO ONE SIDE (TO BE CLEANED AS SPECIAL ITEM)<br>4. REMOVE POSITIVE THROTTLE ASSEMBLY<br>a. USE PROPER SOCKET AND RATCHET<br>b. TURN NUT TO LEFT (COUNTER-CLOCKWISE)<br>c. PLACE NUT AND WASHER IN CONTAINER |

# TASK SHEET

VIII-C-19b(TS)

**TASK:** DISASSEMBLE ONE BARREL CARBURETOR COVER

**JOB:** REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE ACCLERATOR PUMP | 1. REMOVE ACCELERATOR PUMP OPERATING ROD RETAINER SCREW |
| | a. USE PROPER SCREWDRIVER |
| | b. TURN SCREW TO LEFT (COUNTER-CLOCKWISE) |
| | c. PLACE SCREW IN CONTAINER |
| | 2. LIFT OUT RETAINER |
| | 3. ROTATE PUMP OPERATING ROD |
| | 4. DISCONNECT PUMP DRIVE SPRING |
| | a. USE FINGERS TO REMOVE LOCK |
| | b. PLACE LOCKS IN CONTAINER |
| | 5. REMOVE ACCELERATING PUMP ASSEMBLY |
| | NOTE: PLACE PUMP STEM AND CUP WITH CHOKE |
| | 6. ROTATE PUMP OPERATING ROD |
| | 7. REMOVE FROM BOWL COVER |
| | 8. REMOVE PUMP OPERATING ROD GROMMET |
| | NOTE; THE POWER PISTON ASSEMBLY RETAINING RING IS STAKED IN POSITION CARE MUST BE TAKEN AT REMOVAL |
| | 9. REMOVE STAKING WITH SUITABLE SHARP TOOL |
| | 10. REMOVE VACUUM PISTON FROM BOWL COVER |
| | 11. DEPRESS PISTON AND ALLOW IT TO SNAP UP AGAINST RETAINING RING |
| | 12. LIFT OUT OF COVER |

TASK SHEET VIII-C-19c(TS)

**TASK:** DISASSEMBLE ONE BARREL CARBURETOR MAIN BODY

**JOB:** REMOVE AND DISASSEMBLE ONE BARREL CARBURETOR

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. REMOVE FUEL INLET VALVE ASSEMBLY | 1. USE PROPER WRENCH<br>a. TURN FITTING TO LEFT (COUNTER-CLOCKWISE)<br>b. DISCARD VALVE ASSEMBLY<br>2. REMOVE FUEL INLET VALVE GASKET AND DISCARD |
| 2. REMOVE FLOAT ASSEMBLY | 1. REMOVE SPRING FLOAT SHAFT RETAINER<br>a. USE MEDIUM SCREWDRIVER<br>b. PRY RETAINER OUT AND UP<br>c. HOLD RETAINER TO PREVENT IT FROM FLYING AWAY<br>2. LIFT OUT FLOAT SHAFT AND FLOAT ASSEMBLY |
| 3. REMOVE PUMP CHECK BALL AND WEIGHT | 1. TURN CARBURETOR BODY UPSIDE DOWN<br>2. DUMP CHECK BALL AND WEIGHT INTO HAND<br>3. PLACE IN CONTAINER |
| 4. REMOVE MAIN JET | 1. USE PROPER SCREWDRIVER<br>a. TURN JET TO LEFT (COUNTER-CLOCKWISE)<br>b. PLACE JET IN CONTAINER<br>NOTE: BE SURE SCREWDRIVER HAS GOOD SQUARE BLADE |
| 5. REMOVE POWER VALVE | CAUTION: CAREFULLY DEPRESS POWER VALVE NEEDLE WITH PROPER SCREWDRIVER UNTIL SCREWDRIVER BLADE IS SQUARELY SEATED IN SLOT ON TOP OF VALVE<br>1. UNSCREW POWER VALVE<br>a. USE PROPER SCREWDRIVER |

| STEPS | KEY POINTS |
|---|---|
| | b. TURN VAVLE TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE VALVE ASSEMBLY IN CONTAINER<br>NOTE: THE POWER VALVE ASSEMBLY CONSISTS OF SEAT, NEEDLE, AND SPRING. ALL OF THESE COMPONENTS OF SERVICE POWER VALVE SHOULD BE USED IF REPLACEMENT IS REQUIRED |
| 6. SEPARATE MAIN BODY FROM THROTTLE BODY | 1. REMOVE MAIN BODY TO THROTTLE BODY SCREWS<br>a. USE PROPER SCREWDRIVER<br>b. TURN SCREWS TO LEFT (COUNTERCLOCKWISE)<br>c. PLACE SCREWS IN CONTAINER<br>2. SEPARATE MAIN BODY FROM THROTTLE BODY<br>a. STRIKE THROTTLE BODY WITH PLASTIC HAMMER<br>b. DISCARD OLD GASKET<br>3. REMOVE CURB IDLE AIR - FUEL RATIO ADJUSTING SCREW<br>a. TURN LIMITER CAP TO LEANEST POSITION<br>b. LIFT OFF AND DISCARD<br>NOTE: GENTLY TURN IDLE MIXTURE SCREW CLOCKWISE UNTIL IT SEATS. RECORD STARTING POSITION AND EXACT NUMBER OF TURNS REQUIRED TO SEAT SCREW. THIS IS NECESSARY TO REINSTALL IT IN SAME POSITION AFTER REMOVAL AND CLEANING |

VIII-C-20(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | CLEAN, INSPECT, REPAIR, OR REPLACE ONE BARREL CARBURETOR PARTS |
| AIM: | STUDENT WILL BE ABLE TO CORRECTLY AND SAFELY CLEAN, INSPECT, REPAIR, OR REPLACE THE PARTS OF A ONE BARREL CARBURETOR AS ONE TASK IN MAJOR TUNE UP |
| TOOLS AND EQUIPMENT: | SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS, BASIC HAND TOOLS, CLEANING VAT, AND AIR HOSE |
| MATERIALS: | CLEAN RAGS, SOLVENT OR KEROSENE, AND CARBURETOR CLEANER |
| TEACHING AIDS: | I. ED. II 7T, FIGS. 561-567 |
| REFERENCES: | MANUFACTURER'S SERVICE MANUAL OF CARBURETOR AT HAND<br>AUTOMECHANICS, GLENN, PP. 144-168<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266<br>AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT MUST HAVE COMPLETED SATISFACTORILY THE TEST ON INFORMATION LESSONS, COMPLETED SATISFACTORILY THE ASSIGNED TASK IN VIII-C-19, AND PROVE A DESIRE TO ADVANCE TO MANIPULATIVE SKILL LESSON |
| CHECKING STANDARDS: | 1. SELECT PROPER TOOLS AND EQUIPMENT<br>2. PROPER USE OF TOOLS AND EQUIPMENT<br>3. FOLLOW STEPS AND KEY POINTS<br>4. SAFETY PROCEDURES AND SHOP PRACTICES<br>5. DISPLAY A CRAFTSMANLIKE ATTITUDE |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

MUCH OF CARBURETOR PROBLEMS ARE THE RESULTS OF DAMAGED OR WORN, DIRTY OR GUMMED, INORPERATIVE PARTS. IN ORDER FOR CARBURETOR OVERHAUL TO BE SUCCESSFUL, THE PARTS MUST BE PROPERLY CLEANED, CAREFULLY INSPECTED, AND ANY DAMAGED PARTS EITHER REPAIRED OR REPLACED. TO PROPERLY CLEAN THE CARBURETOR REQUIRES A KNOWLEDGE OF THE MATERIAL THE CARBURETOR IS MADE OF. CERTAIN CLEANERS CAUSE A CHEMICAL REACTION WITH THE MATERIAL, THEREBY CAUSING DETERIORATION. THIS LESSON WILL DEMONSTRATE THE CORRECT PROCEDURE FOR CLEANING, INSPECTING, AND THE REPAIR OR REPLACEMENT OF DAMAGED PARTS.

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. SOAK PARTS | 1. SELECT CLEANER<br>NOTE: SOME CLEANERS CAUSE A CHEMICAL REACTION WITH THE CARBURETOR BODY. USE CLEANER RECOMMENDED<br>CAUTION: USE EYE SAFETY PROTECTION WHEN WORKING WITH CARBURETOR CLEANER<br>2. PLACE PARTS IN PARTS TRAY<br>CAUTION: DO NOT PLACE PARTS MADE OF FABRIC OR RUBBER IN CLEANER<br>3. SUBMERGE PARTS IN CLEANER<br>4. SOAK FOR RECOMMENDED TIME<br>NOTE: APPROXIMATELY 30 MINUTES<br>NOTE: KEEP PARTS CLEANER COVER ON |
| 2. REMOVE PARTS | 1. REMOVE TRAY FROM CLEANER<br>2. PERMIT PARTS TO DRAIN INTO TANK<br>CAUTION: AVOID GETTING CLEANER ON SKIN. WASH IMMEDIATELY WITH WATER SHOULD THIS HAPPEN |
| 3. WASH AND BLOW DRY PARTS | 1. RINSE PARTS THOROUGHLY WITH WATER<br>2. BLOW DRY PARTS WITH COMPRESSED AIR<br>NOTE: FORCE AIR THROUGH ALL JETS AND PASSAGES<br>CAUTION: POSITION PARTS SO AS TO PREVENT BLOW BACK OF WATER AND AIR INTO FACE OR EYES<br>NOTE: DO NOT WIRE BRUSH PARTS OR RUN WIRE THROUGH JETS |
| 4. ARRANGE PARTS IN THEIR RESPECTIVE ASSEMBLIES | 1. ARRANGE PARTS IN RESPECTIVE ORDER<br>2. CLEAN PARTS THAT WERE NOT SOAKED IN CLEANER<br>NOTE: WIPE PARTS WITH EITHER CLEAN RAG OR CLEAN RAG DAMPENED WITH KEROSENE OR SOLVENT |
| 5. INSPECT BODY OF CARBURETOR<br>a. AIR HORN BODY<br>b. MAIN BODY<br>c. THROTTLE BODY | 1. INSPECT BODY FOR CRACKS<br>2. CHECK GASKET SURFACE FOR WARPAGE<br>3. CHECK FOR NICKS AND OTHER DEFECTS |

| | |
|---|---|
| 6. INSPECT CHOKE AND THROTTLE SHAFTS | 1. INSPECT SHAFTS FOR GROOVES, WEAR, LOOSENESS, OR BINDING<br>2. INSPECT THROTTLE SHAFT AND BEARING FOR EXCESSIVE WEAR<br>3. INSPECT FOR OUT-OF-ROUND<br>NOTE: REPLACE CARBURETOR ASSEMBLY SHOULD WEAR BE EXCESSIVE |
| 7. INSPECT FASTENERS | 1. INSPECT FOR DAMAGE OR STRIPPED THREADS<br>2. CHECK FOR DISTORTED SPRINGS<br>3. INSPECT BOLT AND SCREW HEADS FOR DAMAGE |
| 8. CHECK IDLE MIXTURE AND SPEED ADJUSTING SCREWS | 1. CHECK SCREW POINT FOR DAMAGE<br>2. INSPECT TAPERED PORTION FOR RIDGED OR GROOVED SURFACE<br>3. CHECK FOR OUT-OF-ROUND |
| 9. INSPECT CHOKE PLATE AND CHOKE PISTON | 1. CHECK CHOKE PLATE FOR NICKS<br>2. CHECK CHOKE PISTON FOR EASE OF OPERATION |
| 10. CHECK FLOAT | 1. TEST FLOAT FOR LEAKAGE<br>NOTE: HOLD FLOAT IN WATER HEATED TO APPROXIMATELY 200° F<br>NOTE: BUBBLES WILL APPEAR IF FLOAT LEAKS<br>2. INSPECT FLOAT ARM FOR ROUGHNESS OR GROOVINGS |
| 11. PREPARE TO REASSEMBLE CARBURETOR | 1. REPAIR PARTS REPAIRABLE<br>2. REPLACE PARTS UNREPAIRABLE |
| 12. CLEAN WORK STATION | 1. SECURE PARTS CLEANER<br>2. DISPOSE OF OILY RAGS<br>3. RESTORE AIR HOSE TO PROPER PLACE<br>4. PROPERLY CLEAN FLOOR AREA |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. FURNISH STUDENTS WITH JOB AND TASK SHEETS.
2. STUDENT TO PRACTICE ON TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. SELECTION OF PARTS CLEANER

## IV. VERIFICATION (CON'T.)

2. PROPER CLEANING OF ALL CARBURETOR PARTS.
3. INSPECTION OF AND REPAIR OR REPLACEMENT OF DAMAGED PARTS.
4. OBSERVANCE OF GOOD WORK SAFETY HABITS.
5. PROPER SECURING OF WORK STATION.
6. PRELIMINARY PREPARATION FOR REASSEMBLY OF CARBURETOR.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY.
2. POINT OUT STEP BY STEP PROCEDURE FOR CLEANING AND INSPECTION.
3. POINT OUT DETERMINING FACTORS IN REPAIR OR REPLACEMENT OF PARTS.
4. REVIEW TASK OF CLEANING, INSPECTING, AND REPAIR OR REPLACEMENT OF PARTS.

SUGGESTED READING FOR STUDENTS:

MANUFACTURER'S SERVICE MANUAL OF CARBURETOR AT HAND
AUTOMECHANICS, GLENN, PP. 144-168
AUTOMOTIVE ENCYCLOPEDIA, TOBOLT, PP. 217-266
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29

THE NEXT LESSON IS: VIII-C-21(S), "REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT"

## JOB SHEET VIII-C-20(J)

**JOB:** CLEAN AND INSPECT ONE BARREL CARBURETOR

**MATERIALS:** CLEAN RAGS AND CARBURETOR CLEANER

**TOOLS AND EQUIPMENT:** SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS, AND BASIC HAND TOOLS

**GENERAL INSTRUCTIONS:** SAFETY GOGGLES OR GLASSES MUST BE WORN AT ALL TIMES TO PROTECT EYES FROM GASOLINE, DIRT, GREASE, AND CARBURETOR CLEANER

CAUTION: DO NOT PERMIT CARBURETOR CLEANER TO COME INTO CONTACT WITH SKIN, EYES OR CLOTHING

**PROCEDURE AND/OR TASKS:**

| | |
|---|---|
| VIII-C-20(TS) | CLEAN ONE BARREL CARBURETOR PARTS |
| VIII-C-20a(TS) | INSPECT AND REPAIR OR REPLACE PARTS ON A ONE BARREL CARBURETOR |

**CHECK POINT:**

1. HAVE INSTRUCTOR CHECK ALL PARTS FOR PROPER CLEANING.
2. CHECK WITH INSTRUCTOR ON PARTS REQUIRING REPAIR OR REPLACEMENT.
3. CHECK WITH INSTRUCTOR BEFORE PROCEEDING TO TASK OF REASSEMBLING CARBURETOR.
4. CORRECT SELECTION OF TOOLS.
5. ADHERENCE TO SAFETY PROCEDURES AND PRACTICE.

## TASK SHEET VIII-C-20(TS)

TASK: CLEAN ONE BARREL CARBURETOR PARTS

JOB: CLEAN AND INSPECT ONE BARREL CARBURETOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SAFETY GOGGLES, WATER, CARBURETOR CLEANER, COMPRESSED AIR

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. SOAK PARTS | 1. SELECT CLEANER<br>NOTE: SOME CLEANERS CAUSE A CHEMICAL REACTION WITH THE CARBURETOR BODY; USE CLEANER RECOMMENDED<br>CAUTION: USE EYE SAFETY PROTECTION WHEN WORKING WITH CLEANER<br>2. PLACE PARTS IN PARTS TRAY<br>CATUION: DO NOT PLACE PARTS MADE OF FABRIC OR RUBBER IN CLEANER<br>3. SUBMERGE PARTS IN CLEANER<br>4. SOAK PARTS FOR RECOMMENDED TIME<br>NOTE: APPROXIMATELY 30 MINUTES<br>NOTE: KEEP PARTS CLEANER COVER ON DURING SOAKING PERIOD |
| 2. REMOVE PARTS | 1. LIFT TRAY FROM CLEANER<br>2. PERMIT PARTS TO DRAIN INTO TANK<br>CAUTION: AVOID GETTING CLEANER ON SKIN. WASH IMMEDIATELY WITH WATER SHOULD THIS HAPPEN |
| 3. WASH AND BLOW DRY PARTS | 1. RINSE PARTS THOROUGHLY WITH WATER<br>2. BLOW DRY PARTS WITH COMPRESSED AIR<br>NOTE: FORCE AIR THROUGH ALL PASSAGES<br>CAUTION: POSITION PARTS SO AS TO PREVENT RETURN OF AIR AND WATER FROM BLOWING BACK INTO FACE OR EYES<br>NOTE: DO NOT WIRE BRUSH PARTS OR RUN WIRE THROUGH JETS<br>3. ARRANGE PARTS IN THEIR RESPECTIVE ASSEMBLIES |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: PARTS THAT ARE NOT SOAKED IN CLEANER MAY BE WIPED CLEAN WITH A CLEAN RAG OR A CLEAN RAG DAMPENED WITH KEROSENE OR A SOLVENT |

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# TASK SHEET

VIII-C-20a(TS)

TASK: INSPECT AND REPAIR OR REPLACE PARTS ON A ONE BARREL CARBURETOR

JOB: CLEAN AND INSPECT ONE BARREL CARBURETOR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS, AND CLEAN RAGS.

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. INSPECT BODY OF CARBURETOR<br>a. AIR HORN BODY<br>b. MAIN HOUSING<br>c. THROTTLE BODY | 1. INSPECT FOR CRACKS IN THE BODY<br>2. CHECK GASKET SURFACES FOR WARPAGE WITH STRAIGHT EDGE<br>3. CHECK FOR NICKS AND OTHER DEFECTS |
| 2. INSPECT CHOKE AND THROTTLE SHAFTS | 1. CHECK SHAFTS FOR GROOVE, WEAR, LOOSENESS, OR BINDING<br>2. INSPECT THROTTLE SHAFT AND ITS BEARING FOR EXCESSIVE WEAR<br>3. INSPECT FOR OUT-OF-ROUNDNESS<br>NOTE: REPLACE CARBURETOR ASSEMBLY SHOULD WEAR BE EXCESSIVE |
| 3. INSPECT FASTENERS | 1. CHECK FOR STRIPPED OR DAMAGED THREADS<br>2. CHECK FOR DISTORTED SPRINGS<br>3. INSPECT BOLTS AND SCREWS FOR DAMAGED HEADS |
| 4. CHECK IDLE MIXTURE SCREWS | 1. INSPECT FOR GROOVED OR RIDGED TAPER PORTION<br>2. INSPECT FOR OUT-OF-ROUND<br>3. CHECK SCREW POINT FOR DAMAGE |
| 5. INSPECT CHOKE PLATE AND CHOKE PISTON | 1. CHECK PLATE FOR NICKS<br>2. CHECK CHOKE PISTON FOR EASE OF OPERATION |
| 6. CHECK FLOAT | 1. TEST FLOAT FOR LEAKAGE<br>NOTE: HOLD FLOAT IN WATER HEATED TO APPROXIMATELY 200° F<br>NOTE: BUBBLES WILL APPEAR IF FLOAT LEAKS<br>2. INSPECT FLOAT ARM FOR ROUGHNESS OR GROOVING |

VIII-C-21(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT |
| AIM: | STUDENT WILL BE ABLE TO PROPERLY REASSEMBLE THE ONE BARREL CARBURETOR AND MAKE INITIAL ADJUSTMENTS THAT ARE REQUIRED IN PREPARATION FOR FINAL TUNE UP ADJUSTMENT. |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SAFETY GOGGLES OR GLASSES, AND SPECIAL CARBURETOR TOOLS |
| MATERIALS: | CLEAN RAGS |
| TEACHING AIDS: | I. ED. II 7T, FIGS. 561-567 |
| REFERENCES: | MANUFACTURER'S SERVICE MANUAL OF CARBURETOR AT HAND<br>AUTOMECHANICS, GLENN, PP. 144-163<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266<br>AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | STUDENT MUST HAVE COMPLETED SATISFACTORILY PREVIOUS TASKS IN REMOVAL, DISASSEMBLY, CLEANING, AND INSPECTION OF CARBURETOR WITH THE APPROVAL OF THE INSTRUCTOR PRIOR TO REASSEMBLY OF THE CARBURETOR |
| CHECKING STANDARDS: | 1. PROPER SELECTION OF TOOLS AND EQUIPMENT<br>2. PROPER USE AND CARE OF TOOLS<br>3. FOLLOW STEPS AND KEY POINTS<br>4. SAFETY PROCEDURES AND SHOP PRACTICES<br>5. DISPLAY CRAFTSMANLIKE ATTITUDE |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

UPON COMPLETION OF CLEANING AND EITHER REPLACEMENT OR REPAIR OF DAMAGED PARTS, THE CARBURETOR IS READY TO BE REASSEMBLED. PROPER SEQUENCE OF STEPS AND CARE IN REASSEMBLING THE CARBURETOR IS VERY IMPORTANT TO THE PROPER OPERATION AND FUNCTION OF THE CARBURETOR. EACH PART MUST BE REASSEMBLED CAREFULLY AND EVERY INITIAL ADJUSTMENT MADE CORRECTLY. THIS LESSON WILL DEMONSTRATE THE CORRECT PROCEDURE FOR THE REASSEMBLY AND INITIAL ADJUSTMENTS TO BE MADE ON THE ONE BARREL CARBURETOR.

| STEPS | KEY POINTS<br>(THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. ASSEMBLE THROTTLE BODY FLANGE ASSEMBLY | 1. INSPECT THROTTLE SHAFT FOR WEAR IN THROTTLE BODY<br>NOTE: REPLACE ASSEMBLY IF WEAR IS EXCESSIVE |
| | 2. ATTACH THROTTLE PLATE TO THROTTLE SHAFT<br>NOTE: POSITION THROTTLE PLATE ON THROTTLE SHAFT WITH THE NOTCH IN THE PLATE ALIGNED WITH THE SLOTTED IDLE PORT. IN THE THROTTLE BODY FLANGE |
| | 3. INSTALL IDLE SCREW AND SPRING<br>NOTE: REPLACE IDLE SCREW IF DAMAGED TO INSURE CORRECT IDLE MIXTURE CONTROL |
| | 4. ADJUST IDLE SCREW LIGHTLY AGAINST SEAT<br>CAUTION: BACK OFF NUMBER OF TURNS COUNTED AT DISASSEMBLY |
| | 5. INSTALL NEW PLASTIC CAP WITH TAB AGAINST STOP |
| | 6. ATTACH THROTTLE BODY TO MAIN BODY<br>NOTE: USE NEW GASKETS<br>CAUTION: TORQUE SCREWS TO THIRTY INCH POUNDS |
| 2. ASSEMBLE CARBURETOR BOWL COVER | NOTE: BEFORE INSTALLING VACUUM PISTON ASSEMBLY IN BOWL COVER, BE SURE AND REMOVE ALL STAKING FROM RETAINER CAVITY |
| | 1. INSTALL SPRING AND PISTON IN VACUUM CYLINDER |
| | 2. SEAT RETAINER PROPERLY |
| | 3. STAKE RETAINER WITH PROPER TOOL |
| | 4. TEST ACCELERATOR PUMP DISCHARGE CHECK BALL SEAT |
| | 5. COAT PUMP PISTON WITH OIL |
| | 6. FILL FUEL BOWL WITH CLEAN GASOLINE |
| | 7. INSTALL ACCELERATOR PUMP DISCHARGE CHECK BALL AND WEIGHT |
| | 8. HOLD DISCHARGE CHECK BALL DOWN |

WITH A SMALL BRASS ROD

9. OPERATE PUMP PLUNGER BY HAND
   NOTE: IF CHECK BALL AND SEAT ARE LEAKING, NO RESISTANCE WILL BE EXPERIENCED WHEN OPERATING PLUNGER. IF VALVE IS LEAKING REMOVE WEIGHT AND STAKE BALL. USE A SUITABLE DRIFT PUNCH. EXERCISE CARE WHEN STAKING BALL TO AVOID DAMAGING BORE CONTAINING PUMP WEIGHT. AFTER STAKING OLD BALL, REMOVE AND REPLACE WITH NEW BALL FROM REPAIR KIT. INSTALL WEIGHT AND CHECK FOR LEAKS. IF NO LEAKS, REMOVE CHECK BALL AND WEIGHT FROM MAIN BODY
10. INSTALL ACCELERATOR PUMP, PUMP OPERATING ROD, AND ROD RETAINER IN BOWL COVER

3. ASSEMBLE CARBURETOR MAIN BODY

1. INSTALL POWER VALVE ASSEMBLY IN BOTTOM OF FUEL BOWL AND TIGHTEN SECURELY
   CAUTION: BE SURE NEEDLE VALVE OPERATES FREELY
2. INSTALL MAIN METERING JET (USE SPECIAL TOOL)
3. INSTALL FLOAT SHAFT AND POSITION ASSEMBLY IN FLOAT SHAFT CRADLE
4. INSERT RETAINING SPRING
   CAUTION: CHECK FLOAT ALIGNMENT TO PREVENT BINDING
   NOTE: A NITROPHYL FLOAT CAN BE CHECKED FOR FULL ABSORPTION BY LIGHTLY SQUEEZING BETWEEN FINGERS. IF WETNESS APPEARS ON SURFACE OR FLOAT FEELS HEAVY (CHECK WITH KNOWN FLOAT) REPLACE FLOAT ASSEMBLY
5. PLACE A NEW GASKET ON FUEL INLET FITTING
6. INSTALL ASSEMBLY INTO MAIN BODY
7. TIGHTEN SECURELY
   NOTE: WHEN REPLACING NEEDLE AND SEAT ASSEMBLY (INLET FITTING), FLOAT LEVEL MUST ALSO BE CHECKED,

AS DIMENSIONAL DIFFERENCE BETWEEN OLD AND NEW ASSEMBLIES MAY CHANGE THE FLOAT LEVEL

8. TO ADJUST FLOAT LEVEL PLACE BOWL COVER GASKET ON TOP OF FUEL BOWL
9. HOLD GASKET IN PLACE AND INVERT BOWL
10. PLACE A STRAIGHT EDGE ACROSS GASKET SURFACE

    NOTE: THE PORTION OF FLOAT LUNGS FARTHEST FROM FUEL INLET SHOULD JUST TOUCH STRAIGHT EDGE. IF ADJUSTMENT IS NECESSARY, BEND TANG TO OBTAIN THIS ADJUSTMENT
11. INSERT CHECK BALL AND WEIGHT INTO ACCELERATOR PUMP DISCHARGE WELL
12. CAREFULLY POSITION BOWL COVER ON TOP OF GASKET

    CAUTION: BE SURE LEADING EDGES OF ACCELERATOR PUMP CUP ARE NOT DAMAGED AS IT ENTERS PUMP BORE. BE CAREFUL NOT TO DAMAGE THE MAIN WELL TUBE
13. INSTALL BOWL COVER SCREWS
14. TIGHTEN ALTERNATELY, A LITTLE AT A TIME, TO COMPRESS GASKET EVENLY
15. INSTALL POSITIVE THROTTLE RETURN SPRING
16. INSTALL FAST IDLE CAM AND LINK
17. INSTALL CHECK VACUUM DIAPHRAGM
18. INSTALL BOWL VENT ASSEMBLY

4. ADJUST CARBURETOR CHOKE UNLOADER WIDE OPEN KICK

1. HOLD THROTTLE VALVES IN WIDE OPEN POSITION
2. INSERT SPECIFIED GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE AND INNER WALL OF AIR HORN

    NOTE: WITH A FINGER SLIGHTLY PRESSING AGAINST CONTROL LEVER, A SLIGHT DRAG SHOULD BE FELT AS GAUGE IS BEING WITHDRAWN. IF AN ADJUSTMENT IS NECESSARY, BEND UNLOADER TANG ON THROTTLE LEVER UNTIL CORRECT OPENING HAS BEEN OBTAINED

3. INSPECT CHOKE VACUUM DIAPHRAGM FITTING TO INSURE THAT PASSAGE IS NOT PLUGGED
4. TEST CHOKE DIAPHRAGM FOR INTERNAL LEAK
    a. DEPRESS DIAPHRAGM STEM
    b. PLACE FINGER OVER VACUUM FITTING TO SEAL OPENING
    c. RELEASE DIAPHRAGM STEM
    d. IF THE STEM MOVES MORE THAN 1/16 INCH IN 10 SECONDS THE ASSEMBLY MUST BE REPLACED

5. ADJUST CHOKE VACUUM KICK

1. DISCONNECT CHOKE VACUUM DIAPHRAGM HOSE AT CARBURETOR
2. APPLY FIFTEEN OR MORE INCHES OF VACUUM TO DIAPHRAGM WITH HAND OPERATED VACUUM PUMP
3. INSERT SPECIFIED GAUGE BETWEEN TOP OF CHOKE VALVE AND WALL OF AIR HORN
4. APPLY SUFFICIENT CLOSING PRESSURE ON LEVER TO WHICH CHOKE ROD ATTACHES TO PROVIDE A MINIMUM CHOKE VALVE OPENING WITHOUT DISTORTION OF DIAPHRAGM LINE
    NOTE: CYLINDRICAL STEM OF DIAPHRAGM WILL EXTEND AS INTERNAL SPRING IS COMPRESSED. THIS SPRING MUST BE FULLY COMPRESSED FOR PROPER MEASUREMENT OF VACUUM KICK ADJUSTMENT
5. ADJUSTMENT IS NECESSARY IF SLIGHT DRAG IS NOT FELT WHEN REMOVING GAUGE
6. SHORTEN OR LENGTHEN DIAPHRAGM LINK TO OBTAIN CORRECT CHOKE VALVE OPENING
    NOTE: DO NOT APPLY TWISTING OR BENDING FORCE TO DIAPHRAGM
7. REINSTALL VACUUM HOSE ON CORRECT FITTING

6. ADJUST BOWL VENT VALVE

1. PLACE THROTTLE AT CURB IDLE POSITION
2. MEASURE DISTANCE FROM COVER SUP-

| | |
|---|---|
| | PORT SURFACE DOWN TO FLAT ON PLASTIC BOWL VENT LEVER<br>NOTE: IF ADJUSTMENT IS NECESSARY, TURN BOWL VENT LEVER ADJUSTING SCREW<br>a. USE PROPER SCREWDRIVER<br>b. TURN IN PROPER DIRECTION TO OBTAIN CORRECT MEASUREMENT |
| 7. ADJUST ACCELERATOR PUMP PISTON STROKE | 1. POSITION THROTTLE IN CURB IDLE POSITION<br>2. PLACE ACCELERATOR PUMP OPERATING LINK IN PROPER SLOT IN THROTTLE LEVER<br>3. MEASURE LENGTH OF OPERATING LINK<br>4. SHORTEN OR LENGTHEN TO OBTAIN SPECIFICATIONS |
| 8. ADJUST FAST IDLE CAM POSITION | 1. PLACE FAST IDLE SPEED ADJUSTING SCREW ON SECOND HIGHEST STEP OF FAST IDLE CAM<br>2. MOVE CHOKE VALVE TOWARD CLOSED POSITION WITH LIGHT PRESSURE ON THE CHOKE CONTROL LEVEL<br>3. INSERT SPECIFIED GAUGE BETWEEN TOP OF CHOKE VALVE AND WALL OF AIR HORN<br>4. BEND UPPER ANGLE OF FAST IDLE LINK TO OBTAIN PROPER SETTING |
| 9. CLEAN WORK STATION | 1. PLACE DIRTY RAGS AND EMPTY PARTS BOXES IN PROPER DISPOSAL CONTAINERS<br>2. CLEAN WORK BENCH<br>3. SWEEP WORK AREA<br>4. PREPARE FOR INSTALLATION OF CARBURETOR |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. FURNISH STUDENTS WITH JOB AND TASK SHEETS.
2. STUDENTS TO PRACTICE BY REASSEMBLING CARBURETOR.
3. OBSERVE AND INSPECT PROCEDURE. RETEACH IF NEED ARISES.
4. STUDENT TO GIVE BACK STEPS AND KEY POINTS AS THEY PERFORM TASK.

## IV. VERIFICATION AND OR/EVALUATION (CHECK ON STUDENT'S ABILITY)

1. STUDENTS PUT ON THEIR OWN TO PERFORM TASK.
2. PROPER ASSEMBLING OF CARBURETOR BY STUDENT.
3. OBSERVANCE OF SAFETY HABITS AND CRAFTSMANSHIP.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP IN STAGE II
2. ASK QUESTION OF THE STUDENTS
3. EMPHASIZE SAFETY AND KEY POINTS

SUGGESTED READING FOR THE STUDENT:

AUTOMECHANICS, GLENN, PP. 144-168
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29

THE NEXT LESSON IS: VIII-C-22(S), "INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT"

VIII-C-21(J)

# JOB SHEET
# ON
# FUEL SYSTEM

| | |
|---|---|
| JOB: | REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT |
| MATERIALS: | CLEAN RAGS |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SAFETY GOGGLES OR GLASSES AND SPECIAL CARBURETOR TOOLS |
| GENERAL INSTRUCTIONS: | SAFETY GOGGLES OR GLASSES MUST BE WORN AT ALL TIMES TO PROTECT EYES FROM GASOLINE, CLEANING CHEMICALS, AND DIRT |

| | | |
|---|---|---|
| PROCEDURES: AND/OR TASKS: | VIII-C-21(TS) | ASSEMBLE THROTTLE BODY FLANGE ASSEMBLY |
| | VIII-C-21a(TS) | ASSEMBLE ONE BARREL CARBURETOR BOWL COVER |
| | VIII-C-21b(TS) | ASSEMBLE ONE BARREL CARBURETOR MAIN BODY |
| | VIII-C-21c(TS) | ADJUST UNLOADER WIDE OPEN KICK |
| | VIII-C-21d(TS) | ADJUST CHOKE VACUUM KICK |
| | VIII-C-21e(TS) | ADJUST BOWL VENT VALVE |
| | VIII-C-21f(TS) | ADJUST ACCELERATOR PUMP PISTON |
| | VIII-C-21g(TS) | ADJUST FAST IDLE CAM POSITION |

CHECK POINT:

1. HAVE INSTRUCTOR CHECK CARBURETOR FOR PROPER ADJUSTMENTS.
2. CORRECT SELECTION OF TOOLS.
3. ADHERENCE TO SAFETY PROCEDURES AND PRACTICE.
4. CHECK WITH INSTRUCTOR BEFORE PROCEEDING TO NEXT TASK.

## TASK SHEET

VIII-C-21(TS)

TASK: ASSEMBLE THROTTLE BODY FLANGE ASSEMBLY

JOB: REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND, CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. CHECK THROTTLE SHAFT | 1. CHECK THROTTLE SHAFT FOR EXCESSIVE WEAR IN BODY<br>NOTE: IF WEAR IS EXTREME, IT IS RECOMMENDED THAT CARBURETOR ASSEMBLY BE REPLACED RATHER THAN INSTALLING A NEW SHAFT IN THE OLD BODY |
| 2. INSTALL IDLE SCREWS | 1. PLACE SPRING ON IDLE SCREW<br>2. INSTALL IDLER SCREW IN BODY<br>NOTE: THE TAPERED PORTION OF THE IDLE SCREW MUST BE STRAIGHT AND SMOOTH. IF TAPERED PORTION IS GROOVED OR RIDGED, A NEW SCREW SHOULD BE INSTALLED TO INSURE HAVING CORRECT IDLE MIXTURE CONTROL<br>3. TURN SCREW (CLOCKWISE) LIGHTLY AGAINST SEAT<br>a. USE FINGERS<br>b. DO NOT USE SCREWDRIVER<br>4. BACK OFF NUMBER OF TURNS COUNTED AT DISASSEMBLY<br>5. INSTALL NEW PLASTIC CAP WITH TAB AGAINST STOP |
| 3. ATTACH THROTTLE BODY TO MAIN BODY | 1. USING NEW GASKET INSTALL THROTTLE BODY TO MAIN BODY<br>2. INSTALL SCREWS<br>a. USE SOCKET SCREWDRIVER AND TORQUE WRENCH<br>b. TIGHTEN TO THIRTY INCH POUNDS |

## TASK SHEET VIII-C-21a(TS)

| | |
|---|---|
| TASK: | ASSEMBLE ONE BARREL CARBURETOR BOWL COVER |
| JOB: | REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | BASIC HAND TOOLS, CLEAN RAGS, SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. INSTALL VACUUM PISTON ASSEMBLY | NOTE: BEFORE INSTALLING VACUUM PISTON ASSEMBLY IN BOWL COVER, BE SURE AND REMOVE ALL STAKING FROM RETAINER CAVITY<br>1. INSTALL SPRING AND PISTON IN VACUUM CYLINDER<br>2. SEAT RETAINER PROPERLY<br>3. STAKE RETAINER WITH PROPER TOOL |
| 2. TEST ACCELERATOR PUMP CHECK BALL SEAT | 1. COAT PUMP PISTON WITH OIL<br>2. FILL FUEL BOWL WITH CLEAN GASOLINE<br>3. INSTALL ACCELERATING PUMP DISCHARGE CHECK BALL AND WEIGHT<br>4. HOLD DISCHARGE CHECK BALL DOWN WITH A SMALL BRASS ROD<br>5. OPERATE PUMP PLUNGER BY HAND<br>NOTE: IF CHECK BALL AND SEAT ARE LEAKING, NO RESISTANCE WILL BE EXPERIENCED WHEN OPERATING PLUNGER. IF VALVE IS LEAKING REMOVE WEIGHT AND STAKE BALL. USE A SUITABLE DRIFT PUNCH. EXERCISE CARE WHEN STAKING BALL TO AVOID DAMAGING BORE CONTAINING PUMP WEIGHT. AFTER STAKING OLD BALL, REMOVE AND REPLACE WITH NEW BALL FROM REPAIR KIT. INSTALL WEIGHT AND CHECK FOR LEAK. IF NO LEAKS REMOVE CHECK BALL AND WEIGHT FROM MAIN BODY<br>6. INSTALL ACCELERATOR PUMP, PUMP OPERATING ROD, AND RETAINER IN BOWL COVER |

TASK SHEET VIII-C-21b(TS)

**TASK:** ASSEMBLE ONE BARREL CARBURETOR MAIN BODY

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PLACE CARBURETOR ON STAND | 1. INSTALL POWER VALVE ASSEMBLY IN BOTTOM OF FUEL BOWL<br>a. USE PROPER SPECIAL TOOL<br>b. TURN VALVE ASSEMBLY TO RIGHT (CLOCKWISE)<br>c. TIGHTEN SECURELY<br>CAUTION: BE SURE NEEDLE VALVE OPERATES FREELY AFTER TIGHTENING<br>2. INSTALL MAIN METERING JET<br>a. USE PROPER SPECIAL TOOL<br>b. TURN TO RIGHT (CLOCKWISE)<br>c. TIGHTEN SECURELY<br>CAUTION: BE SURE NEEDLE VALVE OPERATES FREELY AFTER TIGHTENING |
| 2. INSTALL FLOAT ASSEMBLY | 1. INSTALL FLOAT SHAFT IN FLOAT ASSEMBLY<br>2. POSITION FLOAT ASSEMBLY IN FLOAT SHAFT CRADLE<br>3. INSERT RETAINING SPRING<br>a. USE MEDIUM SCREWDRIVER<br>b. SNAP SPRING INTO PLACE<br>CAUTION: ALIGN FLOAT ASSEMBLY TO PREVENT BINDING |
| 3. INSTALL FUEL INLET FITTING | 1. PLACE A NEW GASKET ON FUEL INLET FITTING<br>2. POSITION FLOAT ASSEMBLY IN FLOAT SHAFT CRADLE<br>3. INSERT RETAINING SPRING<br>a. USE PROPER BOX WRENCH<br>b. TURN FITTING TO RIGHT (CLOCKWISE)<br>c. TIGHTEN SECURELY |

| STEPS | KEY POINTS |
|---|---|
| | NOTE: WHEN REPLACING NEEDLE AND SEAT ASSEMBLY (INLET FITTING) FLOAT LEVEL MUST ALSO BE CHECKED |
| 4. ADJUST FLOAT LEVEL | 1. PLACE NEW GASKET ON TOP OF FUEL BOWL<br>2. HOLD GASKET IN PLACE AND INVERT FUEL BOWL<br>3. PLACE STRAIGHT EDGE ACROSS GASKET SURFACE<br>4. THE PORTION OF FLOAT LUNGS FARTHEST FROM FUEL INLET SHOULD JUST TOUCH STRAIGHT EDGE<br>5. BEND FLOAT TANG TO ADJUST |
| 5. INSTALL CHECK BALL AND WEIGHT | 1. INSERT CHECK BALL INTO ACCELERATOR PUMP WELL<br>2. ALIGN CHECK BALL WEIGHT AND DROP INTO WELL |
| 6. INSTALL BOWL COVER | 1. CAREFULLY POSITION BOWL COVER POSITIVE BOWL ON TOP OF GASKET<br>CAUTION: BE SURE LEADING EDGE OF ACCELERATOR PUMP CUP IS NOT DAMAGED AS IT ENTERS BORE. BE CAREFUL NOT TO DAMAGE MAIN WELL TUBE<br>2. INSTALL BOWL COVER SCREWS ALTERNATELY, A LITTLE AT A TIME, TO COMPRESS GASKET EVENLY<br>a. USE PROPER SCREWDRIVER<br>b. TURN SCREWS TO RIGHT (CLOCKWISE)<br>c. TIGHTEN TO SPECIFICATIONS |
| 7. ATTACH OUTSIDE PARTS TO CARBURETOR | 1. INSTALL POSITIVE THROTTLE RETURN SPRING<br>2. INSTALL FAST IDLE CAM AND LINK<br>3. SECURE WITH NUT AND LOCKWASHER<br>a. USE PROPER SOCKET AND TORQUE WRENCH<br>b. TURN NUT TO RIGHT (CLOCKWISE)<br>c. TIGHTEN TO SPECIFICATIONS<br>4. INSTALL CHOKE DIAPHRAGM<br>5. SECURE WITH PROPER SCREWS<br>a. USE PROPER SCREWDRIVER<br>b. TURN SCREWS TO RIGHT (CLOCKWISE) |

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| STEPS | KEY POINTS |
|---|---|
| | c. TIGHTEN SECURELY |
| | 6. INSTALL BOWL VENT ASSEMBLY |
| | 7. SECURE WITH MOUNTING SCREW |
| | a. USE PROPER SCREWDRIVER |
| | b. TURN SCREW TO RIGHT (CLOCKWISE) |

## TASK SHEET VIII-C-21c(TS)

**TASK:** ADJUST ONE BARREL CARBURETOR UNLOADER WIDE OPEN KICK

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION CARBURETOR LINKAGE | 1. HOLD THROTTLE VALVE IN WIDE OPEN POSITION |
| | 2. INSERT SPECIFIED GAUGE BETWEEN EDGE OF CHOKE VALVE AND INNER WALL OF AIR HORN |
| | 3. APPLY SLIGHT PRESSURE AGAINST CONTROL LEVER<br>NOTE: A SLIGHT DRAG SHOULD BE FELT AS GAUGE IS WITHDRAWN |
| 2. ADJUST CHOKE UNLOADED WIDE OPEN KICK | 1. BEND UNLOADED TANG ON THROTTLE LEVER |
| | 2. REMOVE GAUGE WHEN ADJUST REACHES SPECIFICATION |
| 3. INSPECT CHOKE DIAPHRAGM | 1. CHECK CHOKE DIAPHRAGM FITTING OPENING |
| | 2. TEST CHOKE DIAPHRAGM FOR INTERNAL LEAK<br>a. DEPRESS DIAPHRAGM STEM<br>b. PLACE FINGER OVER FITTING TO SEAL OPENING<br>c. IF STEM MOVES MORE THAN 1/16 INCH IN 10 SECONDS REPLACE ASSEMBLY |

TASK SHEET VIII-C-21d(TS)

**TASK:** ADJUST ONE BARREL CARBURETOR CHOKE VACUUM KICK

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, SPECIAL CARBURETOR TOOLS FOR CARBURETOR AT HAND

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE CHOKE LINKAGE | 1. DISCONNECT CHOKE DIAPHRAGM VACUUM HOSE AT CARBURETOR<br>2. APPLY FIFTEEN OR MORE INCHES OF VACUUM TO DISPHRAGM WITH HAND OPERATED PUMP |
| 2. ADJUST CHOKE VALVE | 1. INSERT SPECIFIED GAUGE BETWEEN TOP OF CHOKE VALVE AND WALL OF AIR HORN<br>2. APPLY SUFFICIENT CLOSING PRESSURE ON LEVER TO WHICH CHOKE ROD ATTACHES TO PROVIDE A MINIMUM CHOKE VALVE OPENING WITHOUT DISTORTION OF DIAPHRAGM LINES<br>NOTE: CYLINDRICAL STEM OF DIAPHRAGM WILL EXTEND AS INTERNAL SPRING IS COMPRESSED. THIS SPRING MUST BE FULLY COMPRESSED FOR PROPER MEASUREMENT OF VACUUM KICK ADJUSTMENT<br>3. SHORTEN OR LENGTHEN DIAPHRAGM LINK TO OBTAIN CORRECT CHOKE VALVE OPENING<br>NOTE: DO NOT APPLY TWISTING OR BENDING FORCE TO DIAPHRAGM<br>4. REINSTALL VACUUM HOSE ON CORRECT FITTING |

# TASK SHEET VIII-C-21e(TS)

**TASK:** ADJUST BOWL VENT VALVE ON ONE BARREL CARBURETOR

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, 1/2" WIDE 6" RULE

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION CARBURETOR LINKAGE | 1. PLACE THROTTLE AT CURB IDLE POSITION<br>2. MEASURE DISTANCE FROM COVER SUPPORT SURFACE DOWN TO FLAT PLACE ON PLASTIC BOWL VENT LEVER |
| 2. ADJUST DISTANCE | 1. TURN ADJUSTING SCREW IN PROPER DIRECTION<br>a. USE CORRECT SCREWDRIVER<br>b. TURN COUNTER CLOCKWISE OR CLOCKWISE AS REQUIRED<br>2. SET TO SPECIFICATIONS |

## TASK SHEET

VIII-C-21f(TS)

**TASK:** ADJUST ACCELERATOR PUMP PISTON STROKE ON ONE BARREL CARBURETOR

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS, 1/2" WIDE RULER

**TASK BREAKDOWN:**

| | |
|---|---|
| 1. POSITION ACCELERATOR LINKAGE | 1. PLACE THROTTLE IN CURB IDLE POSITION<br>2. PLACE ACCELERATOR PUMP OPERATING LINK IN PROPER SLOT IN THROTTLE LEVER |
| 2. ADJUST LEVER | 1. MEASURE LENGTH OF OPERATING LINK<br>2. SHORTEN OR LENGTHEN LINK TO OBTAIN SPECIFICATIONS |

**TASK SHEET** **VIII-C-21g(TS)**

**TASK:** ADJUST FAST IDLE CAM POSITION ON ONE BARREL CARBURETOR

**JOB:** REASSEMBLE AND MAKE INITIAL CARBURETOR ADJUSTMENT

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, SAFETY GOGGLES, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION CARBURETOR LINKAGE | 1. PLACE FAST IDLE SPEED ADJUSTING SCREW ON SECOND HIGHEST STEP OF FAST IDLE CAM<br>2. MOVE CHOKE VALVE TOWARD CLOSED POSITION WITH LIGHT PRESSURE ON CHOKE CONTROL LEVER |
| 2. POSITION FAST IDLE CAM | 1. INSERT SPECIFIED GAUGE BETWEEN TOP OF CHOKE VALVE AND WALL OF AIR HORN<br>2. BEND UPPER ANGLE OF FAST IDLE LINK TO OBTAIN PROPER SETTING |

# INSTRUCTOR'S PLAN
# MANIPULATIVE LESSON

| | |
|---|---|
| TASK: | INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT |
| AIM: | STUDENT WILL BE ABLE TO PROPERLY INSTALL CARBURETOR ON VEHICLE AND MAKE FINAL ADJUSTMENTS IN ORDER TO INSURE THE BEST PERFORMANCE AND ECONOMY IN OPERATION OF THE VEHICLE |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, SAFETY GOGGLES OR GLASSES, SPECIAL CARBURETOR TOOLS, SMALL ADJUSTABLE WRENCH, BATTERY PLIERS, AND TACHOMETER |
| MATERIALS: | CLEAN RAGS, SEAT COVER, AND FENDER COVERS |
| TEACHING AIDS: | I. ED. II 7T, FIGS. 561-567 |
| REFERENCES: | MANUFACTURER'S SERVICE MANUAL OF CARBURETOR AT HAND<br>AUTOMECHANICS, GLENN, PP. 144-168<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266<br>AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE SUCCESSFULLY COMPLETED THOSE TASKS IN VIII-C-21 ON THE REASSEMBLY AND INITIAL CARBURETOR ADJUSTMENTS |
| CHECKING STANDARDS: | 1. PROPER INSTALLATION OF CARBURETOR ON VEHICLE<br>2. PROPER SELECTION, USE, AND CARE OF TOOLS<br>3. FINAL PERFORMANCE TEST UPON COMPLETION OF FINAL CARBURETOR ADJUSTMENT<br>4. SAFETY PROCEDURES AND SHOP PRACTICES<br>5. DISPLAY CRAFTSMANLIKE ATTITUDE |

## I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE FINAL TASK IN THE OVERHAUL OF A ONE BARREL CARBURETOR IS THE INSTALLATION ON THE VEHICLE AND FINAL CARBURETOR ADJUSTMENTS. THIS TASK MUST BE PERFORMED PROPERLY TO INSURE CORRECT FUEL AIR RATIO SO AS TO GIVE BEST PERFORMANCE AND ECONOMY. THIS LESSON WILL DEMONSTRATE THE PROPER PROCEDURE FOR ADJUSTING THE CARBURETOR TO PROPER SPECIFICATIONS.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. REINSTALL CARBURETOR ON VEHICLE | 1. INSPECT MATING SURFACES OF CARBURETOR AND INTAKE MANIFOLD |

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|---|---|
| | NOTE: BE SURE BOTH SURFACES ARE CLEAN AND FREE OF NICKS, BURRS, OR ANY OTHER DAMAGE<br>2. PLACE A NEW FLANGE GASKET ON MANIFOLD SURFACE<br>CAUTION: SOME FLANGE GASKETS CAN BE INSTALLED UPSIDE DOWN OR BACKWARDS. TO PREVENT THIS, MATCH HOLES IN FLANGE GASKET WITH HOLES ON BOTTOM OF CARBURETOR, THEN PLACE GASKET PROPERLY ON INTAKE MANIFOLD SURFACE<br>3. CAREFULLY PLACE CARBURETOR ON MANIFOLD WITHOUT TRAPPING CHOKE ROD UNDER CARBURETOR LINKAGE<br>4. INSTALL CARBURETOR NUTS OR BOLTS<br>5. TIGHTEN ALTERNATELY, A LITTLE AT A TIME, TO COMPRESS FLANGE GASKET EVENLY<br>6. DRAW DOWN TIGHTLY TO PREVENT VACUUM LEAK BETWEEN CARBURETOR AND INTAKE MANIFOLD<br>7. CONNECT THROTTLE, CHOKE LINKAGE, AND INLET LINE<br>NOTE: CHECK CAREFULLY FOR WORN OR LOOSE CONNECTIONS<br>NOTE: MAKE SURE CHOKE PLATE OPENS AND CLOSES FULLY WHEN OPERATED. CHECK TO SEE THAT FULL THROTTLE IS OBTAINED |
| 2. INSTALL AIR CLEANER | 1. REFER TO PROPER DIAGRAMS AND INSTALL VACUUM HOSES<br>2. SECURE AIR CLEANER WITH WING NUT |
| 3. CONNECT BATTERY CABLES | 1. CONNECT POSITIVE CABLE<br>2. CONNECT GROUND CABLE<br>3. TIGHTEN CABLE TERMINALS |
| 4. PREPARE VEHICLE FOR FINAL CARBURETOR ADJUSTMENTS | 1. REPLACE GAS TANK CAP<br>2. START ENGINE<br>3. RUN ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED<br>4. TURN OFF IGNITION<br>5. PLACE TRANSMISSION IN NEUTRAL<br>6. SET PARKING BRAKE |
| 5. REMOVE AIR CLEANER | 1. REFER TO: VIII-C-19(TS)"REMOVE AIR CLEANER FROM VEHICLE" |

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|---|---|
| 6. ADJUST FAST IDLE SPEED | 1. COVER ALL VACUUM FITTINGS<br>2. CONNECT TACHOMETER<br>3. OPEN THROTTLE AND CLOSE CHOKE<br>4. CLOSE THROTTLE<br>5. PLACE FAST IDLE SCREW ON HIGHEST SPEED STEP<br>6. MOVE FAST IDLE CAM UNTIL SCREW DROPS TO SECOND HIGHEST SPEED STEP<br>7. START ENGINE<br>8. ADJUST RPM TO SPECIFICATIONS |
| 7. ADJUST CURB IDLE SPEED | 1. RELEASE FAST IDLE CAM<br>2. TURN CURB IDLE ADJUSTING SCREW IN PROPER DIRECTION<br>3. SET ENGINE RPM TO SPECIFICATIONS |
| 8. REMOVE VEHICLE | 1. REMOVE TACHOMETER<br>2. RECONNECT VACUUM HOSES<br>3. INSTALL AIR CLEANER AS IN PREVIOUS TASK<br>4. PLACE VEHICLE IN ASSIGNED PARKING AREA |
| 9. CLEAN WORK STATION | 1. CLEAN TOOLS<br>2. RETURN TOOLS TO STORAGE AREA<br>3. CLEAN BENCHES AND FLOOR AS IN PREVIOUS LESSONS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. FURNISH STUDENTS WITH JOB AND TASK SHEETS.
2. STUDENTS TO PRACTICE ON TASKS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. PERFORMANCE TEST ON OPERATION OF VEHICLE AFTER JOB COMPLETED.

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY WORK HABITS.
2. POINT OUT STEP BY STEP PROCEDURE FOR CARBURETOR OVERHAUL.
3. REVIEW TASK OF CARBURETOR ADJUSTMENTS.

SUGGESTED READING FOR STUDENTS:

AUTOMECHANICS, GLENN, PP. 144-168
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 217-266
AUTO SERVICE AND REPAIR, STOCKEL, PP. 20-16 TO 20-29

THE NEXT LESSON IS: VIII-B-4(S), "SERVICE CARBURETOR AIR CLEANER"

THE NEXT LESSON IN THIS SERIES IS: VIII-C-24(S), "SERVICE HEAT RISER"

VIII-C-22(J)

# JOB SHEET
# ON
# FUEL SYSTEM

**JOB:** INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT ON A ONE BARREL CARBURETOR

**MATERIALS:** CLEAN RAGS, SEAT COVER, AND FENDER COVER

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS, SAFETY GLASSES OR GOGGLES, SPECIAL CARBURETOR TOOLS, SMALL ADJUSTABLE WRENCH, BATTERY PLIERS, AND TACHOMETER

**GENERAL INSTRUCTIONS:** SAFETY GLASSES OR GOGGLES MUST BE WORN AT ALL TIMES TO PROTECT EYES

**PROCEDURES AND/OR TASKS:**

| | |
|---|---|
| VIII-C-22(TS) | REINSTALL CARBURETOR ON VEHICLE |
| VIII-C-22a(TS) | PREPARE VEHICLE FOR FINAL CARBURETOR ADJUSTMENT |
| VIII-B-4c(TS) | ADJUST FAST IDLE SPEED |
| VIII-B-4d(TS) | ADJUST CURB IDLE SPEED |

**CHECK POINT:**

1. HAVE INSTRUCTOR CHECK FINAL CARBURETOR ADJUSTMENT
2. PROPER SELECTION AND USE OF TOOLS
3. ADHERENCE TO SAFETY PROCEDURE AND PRACTICES
4. CRAFTSMAN LIKE PERFORMANCES AND APPRECIATION FOR TOOLS, WORKMANSHIP, AND STANDARDS

# TASK SHEET

VIII-C-22(TS)

| | |
|---|---|
| TASK: | REINSTALL ONE BARREL CARBURETOR ON VEHICLE |
| JOB: | INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT |
| TRADE: | AUTOMECHANICS |
| TOOLS AND MATERIALS: | BASIC HAND TOOLS, CLEAN RAGS |

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. PREPARE CARBURETOR AND INTAKE MANIFOLD | 1. CLEAN MATING SURFACES<br>2. INSTALL PROPER NEW GASKET ON MANIFOLD<br>CAUTION: SOME FLANGE GASKETS CAN BE INSTALLED UPSIDE DOWN OR BACKWARDS<br>3. MATCH HOLES IN FLANGE GASKET WITH HOLES ON BOTTOM OF CARBURETOR<br>4. PLACE GASKET PROPERLY ON INTAKE MANIFOLD SURFACE |
| 2. INSTALL CARBURETOR | 1. CAREFULLY PLACE CARBURETOR ON MANIFOLD WITHOUT TRAPPING CHOKE ROD UNDER CARBURETOR LINKAGE<br>2. INSTALL CARBURETOR NUTS OR BOLTS<br>3. TIGHTEN ALTERNATELY, A LITTLE AT A TIME, TO COMPRESS FLANGE GASKET EVENLY<br>a. USE PROPER BOX WRENCH<br>b. TURN NUTS OR BOLTS TO RIGHT (CLOCKWISE)<br>c. TIGHTEN SECURELY<br>4. CONNECT THROTTLE LINKAGE<br>a. USE THIN NOSE PLIERS<br>b. RETAIN FUEL LINE FITTING<br>c. TURN LINE NUT TO RIGHT (CLOCKWISE)<br>d. TIGHTEN SECURELY<br>NOTE: CHECK CAREFULLY FOR WORN OR LOOSE CONNECTIONS. MAKE SURE CHOKE PLATE OPENS AND CLOSES FULLY WHEN OPERATED. CHECK TO SEE THAT FULL THROTTLE IS OBTAINED |

TASK SHEET VIII-C-22a (TS)

TASK: PREPARE VEHICLE FOR FINAL ONE BARREL CARBURETOR ADJUSTMENTS

JOB: INSTALL AND MAKE FINAL CARBURETOR ADJUSTMENT

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. ENGINE PREPERATION | 1. INSTALL GAS TANK CAP<br>2. START ENGINE<br>3. RUN ENGINE UNTIL NORMAL OPERATING TEMPERATURE IS REACHED<br>4. TURN OFF IGNITION |
| 2. SAFETY | 1. PLACE TRANSMISSION IN NEUTRAL<br>2. SET PARKING BRAKE |

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

VIII-C-27(I)

| | |
|---|---|
| SUBJECT: | HEAT RISER |
| AIM: | THE STUDENT WILL BE ABLE TO DESCRIBE THE FUNCTION OF A HEAT RISER. |
| TEACHING AIDS: | TRANSPARENCY I. ED. II 7T, FIG. 568<br>HEAT RISER OR HEAT CONTROL VALVE<br>CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, PP. 161-163<br>AUTOMECHANICS, GLENN, P. 101<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 33<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 237-238 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT SHOULD HAVE SATISFACTORILY COMPLETED THE PRECEDING LESSONS ON CARBURETION. |

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### I. PREPARATION (OF THE LEARNER - MOTIVATION)

AS WE KNOW BY NOW, THERE ARE MANY CHECK, CONTROL, AND ASSIST DEVICES BUILT INTO AN AUTOMOTIVE ENGINE. IN THIS LESSON, WE WILL LEARN ABLUT A MECHANISM IN THE EXHAUST SYSTEM WHICH HELPS THE FUEL SYSTEM DO A BETTER JOB: THE HEAT RISER OR HEAT CONTROL VALVE.

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### II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE OF HEAT RISER | 1. PROVIDES HEATING OF FUEL-AIR MIXTURE DURING ENGINE WARM-UP |
| | 2. SPEEDS UP FUEL VAPORIZATION PROCESS |
| | 3. REDUCES CARBURETOR ICING AND ENGINE STALLING |
| | 4. PROMOTES SMOOTHER ACCELERATION |
| B. OPERATION | 1. THERMOSTATIC SPRING CLOSES VALVE WHEN COLD |
| SHOW: TRANSPARENCY FIG. 568 | 2. VALVE FORCES HOT EXHAUST GAS TO CIRCULATE THROUGH PASSAGES OF INTAKE MANIFOLD |

3. GAS TRAVELS AROUND CARBURETOR BASE IN SOME DESIGNS
4. MAY THEN GO INTO EXHAUST MANIFOLD ON OTHER SIDE OR INTO EXHAUST PIPE
5. HEATING CAUSES SPRING TO OPEN VALVE GRADUALLY
6. SOME HAVE COUNTERWEIGHT TO HELP OPEN VALVE
7. ALLOWS HOT GAS DIRECTLY INTO EXHAUST SYSTEM AFTER ENGINE WARMED UP

### C. LOCATION

1. UNIT USUALLY BUILT INTO EXHAUST MANIFOLD
2. POSITIONED IN PASSAGE CONNECTING INTAKE AND EXHAUST MANIFOLDS
3. ENGINES WITH TWO EXHAUST MANIFOLDS HAVE ONLY ONE
4. SOME LOCATED BETWEEN EXHAUST PIPE AND EXHAUST MANIFOLD

### D. MALFUNCTIONS

1. DISTORTION OF SPRING MAY CAUSE FAILURE
2. LEAD SALTS AND CARBON CAN CAUSE VALVE TO FREEZE OR STICK
    - a. VALVE STUCK IN OPEN POSITION MAY CAUSE:
        - (1) DILUTION OF CRANKCASE OIL
        - (2) ICING-UP OF CARBURETOR
        - (3) SLOW WARM-UP
        - (4) STALLING
        - (5) POOR ACCELERATION
    - b. VALVE STUCK IN CLOSED POSITION MAY CAUSE:
        - (1) BURNED VALVES
        - (2) OVERHEATING
        - (3) DETONATION
        - (4) WARPED MANIFOLD

### E. SERVICE

1. VALVE SHAFT SHOULD BE FREE
2. THERMOSTATIC SPRING UNDISTORTED
3. SHAFT CLEANED AND LUBRICATED

CAUTION: SPECIAL HEAT RESISTANT LUBRICANT IS NECESSARY. NEVER USE ENGINE OIL

## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK QUESTIONS TO STIMULATE CLASS DISCUSSION AND CHECK COMPREHENSION OF MATERIALS PRESENTED.

EXAMPLE: WHERE WOULD LEAD SALTS COME FROM THAT CAN CAUSE THE HEAT RISER TO STICK?

ANSWER: IT COMES FROM LEADED GASOLINE.

## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPERHENSION OF MATERIALS PRESENTED.)

QUESTIONS: SIMPLE RECALL

| | | |
|---|---|---|
| 1. | THE HEAT RISER HELPS SPEED_____OF FUEL. | VAPORIZATION |
| 2. | BY HEATING THE FUEL CHARGE IT PROMOTES SMOOTHER_____. | ACCELERATION |
| 3. | A_____SPRING CLOSES THE VALVE WHEN COLD. | THERMOSTATIC |
| 4. | HOT GAS IS FORCED THROUGH PASSAGES IN THE _____MANIFOLD. | INTAKE |
| 5. | IN SOME HEAT RISERS A_____HELPS OPEN THE VALVE. | COUNTER-WEIGHT |
| 6. | AFTER WARM-UP, GAS GOES INTO THE_____PIPE. | EXHAUST |
| 7. | A HEAT RISER IS USUALLY BUILT INTO THE_____MANIFOLD. | EXHAUST |
| 8. | BURNED_____MAY BE CAUSED BY A HEAT RISER STUCK-IN A CLOSED POSITION. | VALVES |
| 9. | DETONATION MAY BE CAUSED BY A HEAT RISER STUCK IN A/AN_____POSITION. | CLOSED |
| 10. | LEAD SALTS AND_____CAN CAUSE A VALVE TO STICK. | CARBON |

## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAYBE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE HEAT RISER PLAYS AN IMPORTANT PART IN THE OPERATION OF A COLD ENGINE BY PROVIDING HEAT TO VAPORIZE GASOLINE MORE QUICKLY.

A THERMOSTATIC SPRING AND COUNTERWEIGHT FUNCTION TO OPEN AND

CLOSE A VALVE WHICH DIRECTS HOT EXHAUST GAS TO AN AREA WHERE IT HEATS THE FUEL CHARGE GOING INTO THE CYLINDERS.

LOCATION OF THE UNIT IS USUALLY BETWEEN INTAKE AND EXHAUST MANIFOLDS, BUT SOME DESIGNERS PLACE IT IN THE CONNECTION BETWEEN EXHAUST PIPE AND EXHAUST MANIFOLD.

SPRING DISTORTION OR A STUCK VALVE ARE MOST COMMON CAUSES OF HEAT RISER MALFUNCTION. FAILURE OF THE RISER TO OPERATE CAN LEAD TO POOR ENGINE PERFORMANCE AND SERIOUS DAMAGE.

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SUGGESTED READING FOR STUDENTS:

AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 287-292

THE NEXT LESSON IS: VIII-C-28(I), "EXHAUST SYSTEM"

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

VIII-C-24(S)

| | |
|---|---|
| TASK: | SERVICE HEAT RISER |
| AIM: | THE STUDENT WILL BE ABLE TO REMOVE, REPAIR, OR REPLACE MANIFOLD HEAT CONTROL VALVE AS AN ASSEMBLY, OR SERVICE COMPONENTS AS REQUIRED IN A SAFE AND EFFICIENT MANNER, EXERCISING MAXIMUM APPRECIATION FOR TOOLS, EQUIPMENT, AND CUSTOMER'S VEHICLE, PERFORMING WORK IN A CRAFTSMANLIKE MANNER, ACCORDING TO SPECIFICATIONS FOR MAKE AND MODEL BEING SERVICED |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, DROP LIGHT, FLOOR HOIST OR JACK, SAFETY STANDS, TORQUE WRENCH, FENDER COVERS, SEAT COVER, DRIP PAN, PARTS CLEANING BRUSH, BUSHING REAMER, ARC WELDER, WELDING RODS, WELDING HOOD |
| MATERIALS: | GASKETS, HEAT RISER LUBRICANT, CLEANING SOLVENT, CLEAN RAGS, AND PENETRATING OIL IN CONTAINER |
| TEACHING AIDS: | MANUFACTURER'S SERVICE MANUAL AND CHARTS |
| REFERENCES: | AUTOMECHANICS, GLENN, PP. 38-42<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 33<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 245-251 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | MUST HAVE SATISFACTORILY PERFORMED THE PRECEDING TASK IN EXHAUST SYSTEM SERVICE ALONG WITH OTHER TASKS PERTAINING TO THE JOB. |
| CHECKING STANDARDS: | 1. SELECTION OF TOOLS AND EQUIPMENT.<br>2. SECURE VEHICLE WITH SAFETY STANDS.<br>3. DISCONNECT ELECTRICAL AND MECHANICAL CONNECTIONS.<br>4. STORAGE OF REMOVED PARTS AND ACCESSORIES.<br>5. USE OF TOOLS AND EQUIPMENT.<br>6. CLEAN WORKING CONDITIONS.<br>7. MANTAIN SAFETY STANDARDS. |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

OPERATION OF THE MANIFOLD HEAT CONTROL VALVE OR HEAT RISER VALVE SHOULD BE INSPECTED PERIODICALLY. THE COUNTERWEIGHT SHOULD RESPOND WHEN ENGINE IS MOMENTARILY ACCELERATED. WHEN MAKING THIS TEST AND NO MOVEMENT IS OBSERVED, THE SHAFT OF HEAT RISER VALVE IS BINDING DUE TO ACCUMULATION OF DEPOSITS OR A WEAK OR BROKEN

THERMOSTAT. THE APPLICATION OF A SUITABLE MANIFOLD HEAT CONTROL VALVE SOLVENT, EVERY OIL CHANGE, TO BOTH ENDS OF MANIFOLD HEAT CONTROL SHAFT AT BUSHINGS, WILL KEEP VALVE WORKING FREELY. THE SOLVENT SHOULD BE APPLIED WHEN MANIFOLD IS COOL AND ALLOWED TO SOAK A FEW MINUTES TO DISSOLVE DEPOSITS. THE MANIFOLD HEAT CONTROL VALVE MUST BE FREE TO OPERATE FOR ENGINE TO PERFORM SATISFACTORILY DURING WARM UP. IF THE VALVE STICKS IN CLOSED POSITION IT CAN CAUSE ENGINE TO OVERHEAT.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | 1. IN WORK BAY, OVER FLOOR HOIST |
| | 2. COVER FENDERS AND SEAT WITH CLEAN COVERS |
| | 3. OPEN HOOD |
| 2. PREPARE VEHICLE | 1. DISCONNECT BATTERY GROUND CABLE |
| | 2. POSITION DROP LIGHT |
| | 3. PLACE TOOLS IN POSITION |
| | 4. PLACE GEAR SHIFT IN NEUTRAL POSITION |
| | 5. SET PARK BRAKE |
| 3. INSPECT HEAT RISER VALVE | 1. FREE MOVEMENT OF SHAFT |
| | 2. SPRING TENSION ON COUNTERWEIGHT |
| | 3. THERMOSTATIC CONTROL |
| | 4. OPENING AND CLOSING ACTION OF VALVE |
| 4. LUBRICATE HEAT RISER | 1. APPLY MANIFOLD HEAT CONTROL VALVE LUBRICANT TO ENDS OF CONTROL VALVE SHAFT AT BUSHINGS<br>NOTE: LUBRICANT SHOULD BE APPLIED WHEN MANIFOLD IS COOL TO DISSOLVE DEPOSITS |
| | 2. SOAK SHAFT FOR SEVERAL MINUTES BEFORE MOVING VALVE |
| | 3. WORK VALVE BACK AND FORTH SEVERAL TIMES |
| | 4. CHECK FOR FREE MOVEMENT OF VALVE SHAFT IN BUSHINGS<br>NOTE: IF VALVE MOVEMENT IS NOT FREE, REPLACE HEAT CONTROL VALVE ASSEMBLY |

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|---|---|
| | SOME MAKES AND MODELS REQUIRE REMOVAL OF EXHAUST MANIFOLD FOR HEAT RISER REPLACEMENT, SOME MODELS HAVE HEAT RISER OR MANIFOLD HEAT CONTROL VALVE ASSEMBLY INSTALLED AS A UNIT BETWEEN EXHAUST PIPE AND MANIFOLD. REPAIR MANUAL FOR VEHICLE BEING SERVICED SHOULD BE REFERRED TO |
| 5. REMOVE EXHAUST PIPE | 1. REMOVE EXHAUST PIPE TO MANIFOLD ATTACHING BOLTS<br>2. REMOVE EXHAUST MANIFOLD TO CYLINDER HEAD ATTACHING BOLTS, NUTS, AND WASHERS<br>3. LIFT EXHAUST MANIFOLD FROM CYLINDER HEAD |
| 6. CLEAN AND INSPECT CYLINDER HEAD AND MANIFOLD | 1. CLEAN MATING SURFACE ON CYLINDER HEAD<br>2. CLEAN MATING SURFACE OF EXHAUST MANIFOLD<br>3. CHECK EXHAUST MANIFOLD SURFACES FOR FLATNESS<br>CAUTION: IF STUDS CAME OUT OF CYLINDER HEAD WHEN NUTS WERE REMOVED, INSTALL NEW STUDS AND APPLY SEALER TO COARSE THREAD END TO PREVENT COOLANT LEAKS<br>4. CHECK EXHAUST MANIFOLD FOR CRACKS AND DISTORTION |
| 7. POSITION EXHAUST MANIFOLD | 1. IN VISE OR HOLDING FIXTURE<br>2. POSITION VALVE PLATE<br>3. GRIND SPOT WELD FROM VALVE PLATE AND SHAFT |
| 8. REMOVE SHAFT ASSEMBLY | 1. REMOVE COUNTERWEIGHT FROM SHAFT END<br>2. REMOVE SHAFT FROM MANIFOLD BUSHINGS<br>3. LIFT OUT VALVE PLATE |
| 9. REMOVE SHAFT BUSHINGS | 1. PRESS OUT BUSHINGS AND SEALS FROM MANIFOLD<br>2. CLEAN BUSHING SEATS |

| | |
|---|---|
| 10. INSTALL BUSHING SEALS | 1. PRESS CUP SEALS INTO MANIFOLD<br>2. CUPPED ENDS FACING OUTWARD<br>3. EXTEND SEALS .100 INCH INTO MANIFOLD |
| 11. INSTALL BUSHINGS | 1. PRESS BUSHINGS INTO MANIFOLD<br>2. FLUSH WITH EXHAUST MANIFOLD OUTER EDGE |
| 12. REAM BUSHINGS | 1. POSITION LINE REAMER INTO BUSHINGS<br>2. LINE REAM BUSHINGS AND SEALS<br>3. TEST FIT OF SHAFT IN BUSHINGS AND SEALS |
| 13. INSTALL COUNTERWEIGHT ON SHAFT | 1. INSTALL VALVE STOP IN SLOT ON COUNTERWEIGHT<br>2. FACE LOOPED END OUTWARD<br>3. POSITION THERMOSTAT ON COUNTERWEIGHT<br>4. PRESS COUNTERWEIGHT ON SHAFT, FLUSH WITH SHAFT END |
| 14. INSTALL NEW SHAFT ASSEMBLY | 1. POSITION THERMOSTATIC SPRING<br>2. INSTALL SHAFT ASSEMBLY THROUGH OUTER BUSHING<br>3. POSITION VALVE PLATE<br>4. SLIDE SHAFT ASSEMBLY THROUGH BUSHINGS, SEALS, AND VALVE PLATE WITH CENTER STRAP FACING FLANGED END OF MANIFOLD |
| 15. SPOT WELD VALVE PLATE | 1. ATTACH HOOK END OF THERMOSTATIC SPRING TO STOP PIN<br>2. POSITION COUNTERWEIGHT END OF SHAFT<br>3. CLOSE VALVE, AND CENTER BETWEEN SEALS<br>4. ARC WELD PLATE TO SHAFT<br>CAUTION: ARC WELD GROUND MUST BE MADE AT COUNTERWEIGHT<br>5. CHECK FREE MOVEMENT OF SHAFT AND VALVE<br>6. INSTALL ANTIRATTLE SPRING |
| 16. INSTALL EXHAUST MANIFOLD | 1. POSITION NEW GASKET ON MOUNTING STUDS<br>2. INSTALL EXHAUST MANIFOLD ON STUDS IN CYLINDER HEAD |

| | |
|---|---|
| | 3. INSTALL ATTACHING NUTS AND TORQUE TO SPECIFICATIONS |
| 17. INSTALL EXHAUST PIPE | 1. POSITION NEW GASKET (IF USED) OVER EXHAUST PIPE ATTACHING STUDS IN EXHAUST MANIFOLD<br>2. INSTALL EXHAUST PIPE TO MANIFOLD<br>3. INSTALL ATTACHING NUTS AND TORQUE TO SPECIFICATIONS |
| 18. CHECK HEAT RISER OPERATION | 1. INSTALL BATTERY GROUND CABLE<br>2. START ENGINE<br>3. CHECK FOR CORRECT VALVE OPERATION<br>4. CHECK FOR EXHAUST LEAKS |
| 19. REMOVE VEHICLE | 1. REMOVE FENDER COVERS<br>2. REMOVE ANY HAND PRINTS, OIL, OR GREASE FROM VEHICLE'S FINISH<br>3. PARK VEHICLE IN APPROVED AREA<br>4. CLEAN STEERING WHEEL AND REMOVE SEAT COVER |
| 20. CLEAN WORK STATION | 1. CLEAN TOOLS AND EQUIPMENT AND RETURN TO STORAGE<br>2. CLEAN WORK BAY AND WORK BENCH<br>3. PLACE USED PARTS AND TRASH IN APPROPRIATE CONTAINERS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS PRACTICE ON THEIR OWN, USING JOB AND TASK SHEETS
2. OBSERVE AND RETEACH AS NEED ARISES
3. CHECK STUDENTS ON KEY POINTS
4. HAVE STUDENTS PERFORM TASK AND GIVE KEY POINTS

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP FROM STAGE II AND EMPHASIZE PERTINENT POINTS

2. REEMPHASIZE NEED FOR SAFETY
3. STRESS POINTS CONCERNING CARE OF CUSTOMER PROPERTY
4. EMPHASIZE CLEANLINESS WITH WORK
5. REEMPHASIZE HIGHLIGHTS OF KEY POINTS

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SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 44-45
AUTOMOTIVE ENCYCLOPEDIA, PP. 299-303
AUTO SERVICE AND REPAIR, CH. 33

THE NEXT LESSON IS: VIII-C-25(S), "RECONDITION EXHAUST SYSTEM"

VIII-C-24(J)

# JOB SHEET
# IN
# SERVICE HEAT RISER

| | |
|---|---|
| JOB: | RECONDITION HEAT RISER VALVE ASSEMBLY |
| MATERIALS: | GASKETS, CLEAN RAGS, HEAT RISER LUBRICANT, PENETRATING OIL, NEW HEAT RISER ASSEMBLY PARTS, AND NEW BOLTS AND NUTS |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, DROP LIGHT, FLOOR HOIST OR JACK, SAFETY. STANDS, SAFETY GOGGLES, CLEAN SEAT AND FENDER COVERS, DRIP PAN, PARTS CLEANING PAN, BRUSH AND SOLVENT, BUSHING REMOVER-INSTALLER, REAMER, ARC WELDER, HOOD, AND STEEL RODS, STRAIGHT EDGE, FEELER GAUGE, AND TORQUE WRENCH |
| GENERAL INSTRUCTIONS: | WEAR EYE PROTECTION, BE ALERT AND WORK SAFELY. USE REFERENCE MATERIAL AS NEEDED. PERFORM EACH STEP IN SEQUENCE. ASK QUESTIONS. FOLLOW INSTRUCTIONS. |
| PROCEDURES AND/OR TASKS: | VIII-C-23(TS) POSITION AND PREPARE VEHICLE<br>VIII-C-24(TS) REMOVE EXHAUST MANIFOLD<br>VIII-C-24a(TS) REMOVE HEAT RISER VALVE ASSEMBLY<br>VIII-C-24b(TS) REPLACE HEAT RISER VALVE ASSEMBLY |
| CHECK POINT: | HAVE INSTRUCTOR CHECK EACH PROCEDURE DURING PERFORMANCE OF TASK |

TASK SHEET VIII-C-24(TS)

**TASK:** REMOVE EXHAUST MANIFOLD

**JOB:** RECONDITION HEAT RISER VALVE ASSEMBLY

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, DROP LIGHT, FENDER AND SEAT COVER, PENETRATING OIL, HEAT RISER LUBRICANT, DRIP PAN, AND CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. IN WORK BAY, OVER HOIST, OR JACK<br>2. CLEAR WORK AREA AROUND VEHICLE<br>3. EQUIPMENT AND SAFETY STANDS NEARBY |
| 2. PREPARE VEHICLE | 1. RAISE FRONT OF VEHICLE, IF NECESSARY<br>2. PLACE SAFETY STANDS IN POSITION<br>3. OPEN HOOD AND COVER FENDER<br>4. COVER SEAT WITH CLEAN COVER<br>5. DISCONNECT BATTERY GROUND<br>6. SET PARK BRAKE |
| 3. LOOSEN EXHAUST MANIFOLD NUTS | 1. SOAK EXHAUST MANIFOLD AND EXHAUST PIPE ATTACHING NUT WITH PENETRATING OIL<br>2. LOOSEN EXHAUST MANIFOLD ATTACHING NUTS. (DRIP PAN UNDER MANIFOLD)<br>NOTE: SOME MODELS MAY REQUIRE REMOVAL OF ALTERNATOR OR AIR CONTITIONING COMPONENTS BEFORE EXHAUST MANIFOLD CAN BE REMOVED<br>3. REMOVE EXHAUST MANIFOLD ATTACHING NUTS |
| 4. REMOVE EXHAUST MANIFOLD | 1. REMOVE EXHAUST PIPE TO MANIFOLD ATTACHING NUTS<br>2. SEPARATE EXHAUST PIPE AND EXHAUST MANIFOLD<br>3. LIFT EXHAUST MANIFOLD FROM CYLINDER HEAD STUDS<br>NOTE: IF ANY CYLINDER HEAD STUDS WERE LOOSENED WHEN EXHAUST MAN- |

| STEPS | KEY POINTS |
|---|---|
| | IFOLD ATTACHING NUTS WERE REMOVED, COAT NEW STUD COARSE THREAD END WITH SEALER AND INSTALL. COOLANT MAY LEAK AROUND STUD THREADS |
| | 4. SCRAPE OFF ALL OLD GASKETS |
| 5. CLEAN WORK STATION | 1. AS IN PREVIOUS TASKS |

## TASK SHEET VIII-C-24a(TS)

**TASK:** REMOVE HEAT RISER VALVE ASSEMBLY

**JOB:** RECONDITION HEAT RISER VALVE ASSEMBLY

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, BRUSHING REMOVER - INSTALLER, FENDER AND SEAT COVERS, PENETRATING OIL, DRIP PAN, CLEAN RAGS, HEAT RISER LUBRICANT, DROP LIGHT, AND GRINDER

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS PER VIII-C-24(TS) |
| 2. PREPARE VEHICLE | AS PER TASK VIII-C-24(TS) |
| 3. INSPECT HEAR RISER | 1. FREE MOVEMENT OF SHAFT IN BUSHINGS<br>2. COUNTERWEIGHT RETURN<br>3. OPENING AND CLOSING OF VALVE |
| 4. POSITION MANIFOLD | 1. POSITION EXHAUST MANIFOLD IN VISE OR HOLDING FIXTURE<br>2. POSITION HEAT RISER VALVE PLATE - WELD UP<br>3. GRIND SPOT WELD FROM VALVE PLATE AND SHAFT |
| 5. REMOVE SHAFT AND VALVE | 1. PRESS COUNTERWEIGHT OFF SHAFT END<br>2. SLIDE SHAFT FROM BUSHING IN EXHAUST MANIFOLD<br>3. LIFT OUT VALVE PLATE |
| 6. REMOVE SHAFT BUSHINGS | 1. PRESS BUSHINGS AND SEALS FROM MANIFOLD<br>2. CLEAN BUSHING SEATS |
| 7. CLEAN WORK STATION | 1. AS IN PREVIOUS TASKS |

## TASK SHEET

**TASK:** REPLACE HEAT RISER VALVE ASSEMBLY

**JOB:** RECONDITION HEAT RISER VALVE ASSEMBLY

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, BUSHING REAMER, BUSHING INSTALLING TOOL, FENDER AND SEAT COVERS, HEAT RISER LUBRICANT, DRIP PAN, BRUSH AND CLEANING SOLVENT, CLEAN RAGS, COMPRESSED AIR, ARC WELDER AND STEEL WELDING RODS, WELDING HOOD, SAFETY GOGGLES

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | AS PER TASK VIII-C-24(TS) |
| 2. PREPARE VEHICLE | AS PER TASK VIII-C-24(TS) |
| 3. INSPECT MANIFOLD AND MATING SURFACES | 1. CLEAN OLD GASKETS OFF CYLINDER HEAD AND MANIFOLD<br>2. INSPECT CYLINDER HEAD AND EXHAUST MANIFOLD MATING SURFACES FOR BURRS AND DISTORTION<br>3. CHECK MANIFOLD FOR FLATNESS<br>NOTE: USE STRAIGHT EDGE OR SURFACE PLATE. CHECK FOR FLATNESS WITH FEELER GAUGE |
| 4. INSTALL SHAFT BUSHING SEALS | 1. PRESS NEW CUP SEALS INTO MANIFOLD<br>2. CUPPED ENDS FACING OUTWARD<br>3. EXTEND SEALS .100 INCH INTO MANIFOLD |
| 5. INSTALL BUSHINGS | 1. POSITION HEAT RISER BUSHING DRIVER WITH NEW BUSHING<br>2. DRIVE OR PRESS BUSHING INTO MANIFOLD<br>3. FLUSH WITH OUTER EDGE OF EXHAUST MANIFOLD |
| 6. FIT SHAFT TO BUSHINGS | 1. POSITION CORRECT SIZE LINE REAMER INTO BUSHING<br>2. LINE REAM SHAFT BUSHINGS AND SEALS<br>3. TEST FIT OF SHAFT IN BUSHING<br>4. REAM UNTIL SHAFT TURNS FREE IN BUSHING |

| STEPS | KEY POINTS |
|---|---|
| 7. INSTALL COUNTERWEIGHT | 1. INSTALL VALVE STOP IN SLOT ON COUNTERWEIGHT |
| | 2. FACE LOOPED END OUTWARD |
| | 3. POSITION THERMOSTAT ON COUNTERWEIGHT |
| | 4. PRESS COUNTERWEIGHT ONTO SHAFT END |
| | 5. FLUSH WITH END OF SHAFT |
| 8. INSTALL SHAFT ASSEMBLY | 1. POSITION NEW THERMOSTATIC SPRING |
| | 2. INSTALL NEW SHAFT ASSEMBLY THROUGH OUTER VEHICLE |
| | 3. POSITION VALVE PLATE IN MANIFOLD, CENTER STRAP FACING FLANGED END |
| | 4. SLIDE SHAFT ASSEMBLY THROUGH OUTER BUSHING, SEALS, AND VALVE PLATE |
| 9. POSITION SHAFT AND PLATE | 1. POSITION SHAFT AND VALVE |
| | 2. ATTACH HOOK END OF THERMOSTATIC SPRING TO STOP PIN |
| | 3. VALVE CLOSED AND CENTERED BETWEEN SHAFT SEALS |
| 10. SPOT WELD | 1. ARC WELDER GROUND TO COUNTERWEIGHT<br>CAUTION: DO NOT ATTACH GROUND AT ANY OTHER POINT. GROUND MUST BE MADE TO SHAFT AND COUNTERWEIGHT |
| | 2. WEAR PROTECTIVE WELDING HOOD |
| | 3. SPOT WELD VALVE TO SHAFT |
| | 4. INSTALL ANTIRATTLE SPRING |
| | 5. CHECK FREE MOVEMENT OF SHAFT IN BUSHINGS |
| 11. INSTALL EXHAUST MANIFOLD | 1. POSITION NEW EXHAUST MANIFOLD GASKET ON CYLINDER HEAD MOUNTING STUDS |
| | 2. PLACE EXHAUST MANIFOLD OVER MOUNTING STUDS AND FLUSH WITH GASKET |
| | 3. INSTALL EXHAUST MANIFOLD ATTACHING NUTS (NEW) |
| | 4. TORQUE TO SPECIFICATIONS |
| 12. INSTALL EXHAUST PIPE | 1. POSITION NEW GASKET (IF ANY USED) OVER EXHAUST PIPE ATTACHING STUDS IN MANIFOLD |

| STEPS | KEY POINTS |
|---|---|
| | 2. POSITION EXHAUST PIPE INTO MANIFOLD |
| | 3. INSTALL ATTACHING NUTS |
| | 4. TIGHTEN EVENLY AND TORQUE TO SPECIFICATIONS |
| 13. VEHICLE CHECK | 1. INSTALL BATTERY GROUND CABLE |
| | 2. START ENGINE |
| | 3. INCREASE AND DECREASE R. P. M. |
| | 4. CHECK OPERATION OF HEAT RISER VALVE |
| | 5. CHECK FOR EXHAUST LEAKS |
| 14. REMOVE VEHICLE | 1. REMOVE FENDER COVERS AND CLOSE HOOD |
| | 2. WIPE VEHICLE FREE OF ANY OIL, GREASE, OR HAND PRINTS |
| | 3. REMOVE JACKS AND DRIP PAN |
| | 4. PARK VEHICLE IN APPROVED AREA |
| | 5. WIPE STEERING WHEEL AND REMOVE SEAT COVER |
| 15. CLEAN WORK STATION | 1. CLEAN TOOLS AND EQUIPMENT |
| | 2. RETURN TOOLS, EQUIPMENT, AND SUPPLIES TO STORAGE |
| | 3. CLEAN WORK BAY AND BENCH |
| | 4. PLACE ALL USED PARTS AND TRASH IN APPROPRIATE CONTAINERS |

VIII-C-28(I)

## INSTRUCTOR'S PLAN
## INFORMATIONAL LESSON

| | |
|---|---|
| SUBJECT: | EXHAUST SYSTEM |
| AIM: | THE STUDENT WILL BE ABLE TO COMPARE TYPES OF EXHAUST SYSTEMS AND DESCRIBE THE CONSTRUCTION AND MATERIALS OF THE COMPONENTS. |
| TEACHING AIDS: | TRANSPARENCIES I. ED. II 7T, FIGS. 568-574<br>CHALKBOARD |
| MATERIALS: | CHALK |
| REFERENCES: | AUTOMOTIVE MECHANICS, CROUSE, PP. 169-174<br>AUTOMECHANICS, GLENN, PP. 39-41<br>AUTO SERVICE AND REPAIR, STOCKEL, CH. 33<br>AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT, PP. 287-292 |
| PREREQUISITE EXPERIENCE OF THE LEARNER: | THE STUDENT MUST HAVE READ THE REFERENCES FOR THIS LESSON |

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## I. PREPARATION (OF THE LEARNER - MOTIVATION)

WE HAVE TRACED GASOLINE THROUGH THE FUEL SYSTEM TO THE CYLINDERS, SEEN HOW IT WAS IGNITED BY SPARK PLUGS, AND LEARNED THAT IT RELEASES POWER IN THE PROCESS OF CHANGING STATES. COMBUSTION IS, IN FACT, AN EXPLOSION THAT OCCURS THOUSANDS OF TIMES EVERY MINUTE IN A RUNNING ENGINE. THE END RESULT IS A MIXTURE OF GASES OF WHICH ONE IS VERY POISONOUS. HOW THE EXPLOSIONS ARE QUIETED AND THE GASES SAFELY REMOVED IS OUR TOPIC TODAY: THE EXHAUST SYSTEM.

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## II. PRESENTATION (OF THE INFORMATION)

| INSTRUCTIONAL TOPICS<br>TEACHING POINTS | THINGS FOR STUDENTS TO DO<br>THINGS FOR INSTRUCTOR TO DO OR SAY |
|---|---|
| A. PURPOSE OF EXHAUST SYSTEM | 1. CONVEYS POISON GASES FROM ENGINE TO ATMOSPHERE |
| | 2. REDUCES NOISE BY SLOWING EXPANSION RATE OF GASES |
| | 3. COOLS THE GASES AND RELEASES THEM AT THE REAR |
| | 4. ALLOWS SPACE FOR FUEL-AIR MIXTURE IN THE CYLINDER |
| B. TYPES | 1. CONVENTIONAL TYPE HAS ONE OF EACH COMPONENT |

2. DUAL SYSTEM HAS TWO OF EACH
3. V-8 ENGINES MAY HAVE CROSSOVER PIPE CONNECTING THE MANIFOLDS
4. MANY CARS HAVE A RESONATOR BEHIND OR IN FRONT OF THE MUFFLER

C. COMPONENTS AND OPERATIONS

1. EXHAUST MANIFOLD MADE OF CAST IRON
   - a. BOLTS TO HEAD OR BLOCK OF ENGINE
   - b. HAS MINIMUM OF SHARP TURNS
   - c. USUALLY HOUSES THERMOSTATIC HEAT CONTROL VALVE AS EXPLAINED IN LAST LESSON
   - d. ALL V-8 ENGINES HAVE TWO MANIFOLDS
   - e. FLANGE CONNECTS IT TO EXHAUST PIPE
2. EXHAUST PIPE COMPOSED OF STEEL
   - a. MOUNTED ON HANGERS FROM CAR FRAME
   - b. HAS NO SHARP TURNS OR BENDS
   - c. SIZE HAS DIRECT RELATIONSHIP WITH DISPLACEMENT TO REDUCE BACK PRESSURE
   - d. CONNECTS EXHAUST MANIFOLD AND MUFFLER
3. MUFFLERS VARY IN MATERIALS AND DESIGN
   - a. OUTER SHELL OF TIN, STEEL, OR STAINLESS STEEL
   - b. SOME HAVE STRAIGHT THROUGH DESIGN WHICH REDUCES BACK PRESSURE
   - c. INSIDE COMPOSED OF CHAMBERS IN MOST
     - (1) SIZE AND ARRANGEMENT HELP REDUCE NOISE
     - (2) USUALLY DESIGNED TO CIRCULATE AND COOL GASES
     - (3) SMOOTHES GAS FLOW BY REDUCING OVERLAP OF POWER STROKE PRESSURE
     - (4) EXPANSION OF GASES REDUCES BACK PRESSURE IN CYLINDERS

        (5) CHAMBERS LINED WITH STEEL WOOL, GLASS WOOL, OR OTHER MATERIAL
        (6) MUFFLER OUTLET FITS INTO TAIL PIPE

4. TAIL PIPE CARRIES GASES TO REAR OF VEHICLE
5. RESONATOR FOUND ON MOST MODERN VEHICLES
    a. INTERNAL CONSTRUCTION SIMILAR TO MUFFLER
    b. HAS FEWER CHAMBERS
    c. ALLOWS USE OF MUFFLER PRODUCING LESS BACK PRESSURE

D. MALFUNCTIONS AND REQUIREMENTS

1. BACK PRESSURE AN IMPORTANT CONSIDERATION
    a. TOO MUCH REDUCES POWER AND GASOLINE EFFICIENCY
    b. CAUSED BY DENTS OR KINKS IN EXHAUST SYSTEM

NOTE: REPLACEMENT OF PIPES SHOULD BE MADE WITH THOSE OF EQUAL SIZE. NEVER USE SMALLER PIPES

SHOW: TRANSPARENCIES FIGS. 570-573

2. CORROSION OCCURS ON INSIDE AND OUT
    a. COMBUSTION PROCESS PRODUCES EQUAL AMOUNT OF WATER FOR GASOLINE BURNED
    b. WATER CARRIED OUT EXHAUST SYSTEM
    c. HIGH TEMPERATURE EVAPORATES WATER
    d. SHORT DISTANCE OPERATION DOES NOT PRODUCE NECESSARY TEMPERATURES
    e. EXHAUST SYSTEM RUSTS RAPIDLY
    f. MUFFLER RUSTS OUT FROM INSIDE
3. RUST RESISTANT MATERIALS REQUIRED
    a. CERAMIC COATING ON INSIDE OF PARTS
    b. SPECIAL METAL ALLOYS SUCH AS STAINLESS STEEL MAY BE USED
4. CARBON ACCUMULATION, LEAKS, WEAR CAUSE NEED FOR REPAIRS

## II. PRESENTATION (CON'T.)

a. LEAKS CAN CAUSE GAS TO ACCUMULATE IN VEHICLE

b. CARBON MONOXIDE CAN CAUSE DROWSINESS AND DEATH

CAUTION: RUNNING AN ENGINE IN A CLOSED SHOP WITHOUT VENTILATION CAN CAUSE NAUSEA, DROWSINESS, AND DEATH

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## III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ASK QUESTIONS TO STIMULATE CLASS DISCUSSION AND CHECK COMPREHENSION OF MATERIALS PRESENTED.

EXAMPLE: WHAT ARE SOME ADVANTAGES OF A DUAL EXHAUST SYSTEM?

ANSWER: A DUAL SYSTEM PRODUCES LESS BACK PRESSURE ON THE ENGINE. THIS RESULTS IN MORE HORSEPOWER DELIVERED AND BETTER GASOLINE MILEAGE.

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## IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE - FALSE TEST

1. SLOWING THE RATE OF GAS EXPANSION REDUCES THE SOUND IT MAKES. T
2. CROSSOVER PIPES ARE FOUND IN EXHAUST SYSTEMS OF IN-LINE ENGINES. F
3. EXHAUST PIPES ARE USUALLY MADE OF CAST IRON. F
4. V-8 ENGINES HAVE TWO MANIFOLDS. T
5. THE CONNECTION BETWEEN MUFFLER AND TAIL PIPE IS CALLED A FLANGE. F
6. A SHARP KINK IN THE TAIL PIPE CAN CAUSE AN ENGINE TO USE EXCESSIVE AMOUNTS OF FUEL. T
7. RESONATORS ARE DESIGNED TO HELP DELIVER MORE POWER TO THE REAR END. T
8. WATER IN THE EXHAUST CAUSES MUFFLERS TO RUST FROM THE INSIDE. T

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## IV. VERIFICATION (CON'T.)

9. HIGH OPERATING TEMPERATURES CAUSE AN EXHAUST SYSTEM TO LAST LONGER. T

10. MUFFLERS RUST FROM THE OUTSIDE IN. F

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## V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

EXHAUST SYSTEMS HAVE THE IMPORTANT FUNCTION OF REMOVING POISONOUS GASES PRODUCED BY COMBUSTION AND SAFELY CONDUCTING THEM TO THE REAR OF THE VEHICLE. AT THE SAME TIME IT ALLOWS GASES TO EXPAND MORE SLOWLY, REDUCING NOISE.

THESE SYSTEMS MAY BE EITHER SINGLE, DUAL, OR COMBINATIONS, BUT BASIC COMPONENTS USUALLY INCLUDE AN EXHAUST MANIFOLD, EXHAUST PIPE, MUFFLER, TAIL PIPE, AND RESONATOR.

RUST IS THE PRIMARY CAUSE OF EXHAUST SYSTEM MALFUNCTION. USUALLY STARTING ON THE INSIDE OF THE SYSTEM, IT CAN CAUSE VERY DANGEROUS LEAKAGE OF POISONOUS GAS INTO THE VEHICLE.

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SUGGESTED READING FOR THE STUDENT:

AUTO SERVICE AND REPAIR, STOCKEL, CH. 23

THE NEXT LESSON IS: IX-A-1(I) "AIR CONDITIONING DIAGNOSIS"

VIII-C-25(S)

## INSTRUCTOR'S PLAN
## MANIPULATIVE LESSON

**TASK:** RECONDITION EXHAUST SYSTEM

**AIM:** THE STUDENT WILL BE ABLE TO REMOVE, REPAIR, OR REPLACE THE EXHAUST SYSTEM OR COMPONENTS ON MOST VEHICLES. STUDENT WILL BE ABLE TO WORK IN A SAFE, EFFICIENT, CRAFTSMANLIKE MANNER, EXERCISING MAXIMUM APPRECIATION FOR TOOLS, EQUIPMENT, AND THE CUSTOMER'S VEHICLE. THE STUDENT WILL ALSO BE ABLE TO ACCURATELY INTERPRET INSTRUCTIONS FROM REPAIR MANUALS FOR MAKE AND MODEL VEHICLE BEING SERVICED.

**TOOLS AND EQUIPMENT:** BASIC HAND TOOLS, DROP LIGHT, FLOOR HOIST OR JACK, SAFETY STANDS, TORQUE WRENCH, HACKSAW, PIPE CUTTING TOOLS, FENDER AND SEAT COVER, SAFETY GOGGLES, PIPE EXPANDER, CLEAN RAGS, WIRE BRUSH, (PNEUMATIC CUTTER WITH ATTACHMENTS-OPTIONAL)

**MATERIALS:** GASKETS, PIPES, MUFFLER CLAMPS, HANGERS, BOLTS AND NUTS, PENETRATION OIL (IN CONTAINER).

**TEACHING AIDS:** MANUFACTURER'S SERVICE MANUALS AND CHARTS, TRANSPARENCIES I ED. II 7 T FIG. #569, 570, 571, 572, 573, 574, 575, 576

**REFERENCES:**
AUTOMECHANICS, GLENN, PP. 38-42
AUTO SERVICE AND REPAIR, STOCKEL CH. 33
AUTOMOTIVE ENCYCLOPEDIA, TOBOLDT PP. 299-303

**PREREQUISITE EXPERIENCE OF THE LEARNER:** MUST HAVE SATISFACTORILY PERFORMED THE PRECEDING TASKS IN EXHAUST SYSTEM SERVICE ALONG WITH OTHER TASKS PERTAINING TO THE JOB

**CHECKING STANDARDS:**
1. SELECTION OF TOOLS AND EQUIPMENT
2. SECURE VEHICLE WITH SAFETY STANDS
3. DISCONNECT ELECTRICAL AND MECHANICAL CONNECTIONS
4. COMPLYING WITH SHOP AND SAFETY STANDARDS
5. WORKING IN CRAFTSMANLIKE MANNER
6. USE OF TOOLS AND EQUIPMENT
7. STORAGE OF REMOVED PARTS
8. CLEAN WORKING CONDITIONS

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## I. PREPARATION (OF THE LEARNER)

THE EXHAUST SYSTEM OF AN AUTOMOBILE CONSISTS OF THE EXHAUST MANIFOLD, EXHAUST PIPE, MUFFLER, TAIL PIPE, CLAMPS, AND HANGERS. SOME

## I. PREPARATION (CON'T.)

MODELS ARE EQUIPPED WITH A CATALYTIC CONVERTER, AND SOME MAY BE EQUIPPED WITH AN EXTRA MUFFLER OR RESONATOR. IT IS DESIGNED TO CONDUCT THE BURNED GASES (OR EXHAUST) FROM THE ENGINE, SILENCE THE NOISE, AND PASS IT THROUGH THE TAIL PIPE TO THE REAR OF THE VEHICLE. THE CATALYTIC CONVERTER FUNCTIONS AS PART OF THE EMISSION CONTROL SYSTEM. EXHAUST SYSTEMS VARY IN TYPES AS TO CAR LINE MAKE, MODEL, YEAR, AND ENGINE TYPE OR SIZE. CORRECT PROCEDURES AND TOOLS ARE NECESSARY TO SATISFACTORILY SERVICE AUTOMOTIVE EXHAUST SYSTEMS. IMPROPER SERVICE TO THE SYSTEMS CAN RESULT IN LEAKAGE, CAUSING DANGEROUS FUMES TO ENTER PASSENGER COMPARTMENT, ANNOYING RATTLES, AND DAMAGE.

## II. PRESENTATION (OF THE SKILLS)

| STEPS | KEY POINTS (THINGS TO REMEMBER TO DO OR SAY) |
|---|---|
| 1. POSITION VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 2. PREPARE VEHICLE | 1. AS PER TASK VIII-C-23(TS)<br>CAUTION: WHEN LIFTING VEHICLE BE CERTAIN LIFT PADS DO NOT CONTACT CATALYTIC CONVERTER AS DAMAGE TO CONVERTER WILL RESULT (IF SO EQUIPPED) |
| 3. CHECK BODY OPENINGS | 1. VISUALLY INSPECT EXHAUST ASSEMBLY FOR CRACKS, POOR OR LOOSE CONNECTIONS, OR DAMAGE<br>2. VISUALLY INSPECT UNDERSIDE OF VEHICLE<br>a. OPEN SEAMS<br>b. HOLES<br>c. POOR "FIT" OF TRUNK LID<br>NOTE: ANY LEAK IN EXHAUST SYSTEM CAN PERMIT EXHAUST FUMES TO ENTER PASSENGER COMPARTMENT THROUGH BODY OPENINGS |
| 4. LOOSEN EXHAUST | 1. APPLY PENETRATING OIL TO ALL BOLTS AND NUTS TO BE REMOVED<br>2. LOOSEN "U" BOLTS AND CLAMPS HOLDING TAIL PIPE TO HANGERS AND MUFFLER<br>3. LOOSEN "U" BOLTS AND CLAMPS HOLDING MUFFLER AND EXHAUST PIPE<br>4. LOOSEN EXHAUST PIPE-MANIFOLD ATTACHING NUTS |

| | |
|---|---|
| 5. REMOVE TAIL PIPE | 1. POSITION CUTTING TOOL AT REAR OF MUFFLER<br>2. SPLIT MUFFLER OUTLET NIPPLE ON OPPOSITE SIDES<br>CAUTION: IF TAIL PIPE ONLY IS BEING REPLACED, BE CAREFUL WHEN CUTTING, DO NOT CUT INNER PIPE<br>3. TWIST TAIL PIPE IN MUFFLER TO LOOSEN<br>4. PULL TAIL PIPE FROM MUFFLER OUTLET NIPPLE |
| 6. REMOVE MUFFLER | 1. POSITION CUTTING TOOL AT FRONT OF MUFFLER<br>2. SPLIT MUFFLER INLET NIPPLE ON OPPOSITE SIDES WITH CUTTER<br>3. HOLD MUFFLER WITH HANDS AND TWIST ON EXHAUST PIPE<br>4. SLIDE MUFFLER FROM EXHAUST PIPE END |
| 7. REMOVE EXHAUST PIPE | 1. REMOVE EXHAUST TO MANIFOLD ATTACHING BOLTS OR NUTS<br>2. MOVE EXHAUST PIPE IN BACK AND FORTH MOTION WHILE TWISTING TO LOOSEN IN MANIFOLD<br>3. LIFT EXHAUST PIPE FROM EXHAUST MANIFOLD |
| 8. PREPARE TO REASSEMBLE | 1. INSPECT MUFFLER AND TAIL PIPE HANGERS<br>a. OUT OF SHAPE<br>b. CRACKS AND RUST<br>c. POSITIONING<br>2. INSPECT HEAT BAFFLES<br>a. BURNED SPOTS<br>b. CRACKS<br>c. POSITIONING<br>3. INSPECT NEW PARTS<br>a. DENTS OR DAMAGE<br>b. CORRECT FOR VEHICLE<br>c. DAMAGE TO GASKETS AND THREADED PARTS<br>NOTE: CORRECT ANY UNUSUAL CONDITION BEFORE MAKING ANY INSTALLATION OF PARTS |

| | |
|---|---|
| 9. INSTALL EXHAUST PIPE | 1. INSTALL NEW EXHAUST FLANGE GASKET (IF REQUIRED)<br>2. POSITION NEW EXHAUST PIPE IN EXHAUST MANIFOLD OUTLET<br>3. INSTALL NEW EXHAUST PIPE ATTACHING NUTS FINGER TIGHT |
| 10. INSTALL MUFFLER | 1. APPLY EXHAUST SYSTEM SEALER TO MUFFLER AND PIPE SLIP JOINTS<br>2. SLIDE MUFFLER INTO POSITION OF EXHAUST PIPE<br>3. INSTALL "U" CLAMP AND TIGHTEN WITH FINGERS |
| 11. INSTALL TAIL PIPE | 1. APPLY EXHAUST SYSTEM SEALER TO MUFFLER AND TAIL PIPE SLIP JOINTS<br>2. POSITION TAIL PIPE IN HANGERS AND MUFFLER<br>3. SLIDE TAIL PIPE INTO MUFFLER OUTLET<br>4. INSTALL "U" CLAMPS AND TIGHTEN WITH FINGERS |
| 12. ALIGN MUFFLER AND PIPES | 1. SEAT MUFFLER FIRMLY ON EXHAUST PIPE OUTLET AND TIGHTEN "U" CLAMPS<br>2. ALIGN AND SEAT TAIL PIPE FIRMLY INTO MUFFLER OUTLET<br>3. HOLD PIPE IN POSITION AND TIGHTEN MUFFLER REAR "U" CLAMP<br>4. POSITION TAIL PIPE HANGERS AND TIGHTEN "U" CLAMPS<br>5. TIGHTEN EXHAUST PIPE TO MANIFOLD NUTS |
| 13. CHECK FLOOR CLEARANCE | 1. CHECK EXHAUST PIPE TO FRAME CLEARANCE<br>2. CHECK MUFFLER TO FLOOR PAN CLEARANCE<br>3. CHECK TAIL PIPE TO FLOOR AND FUEL TANK CLEARANCE<br>CAUTION: EXHAUST SYSTEM COMPONENTS MUST HAVE ADEQUATE CLEARANCE FROM FLOOR PAN TO AVOID POSSIBLE OVERHEATING AND DAMAGE TO PASSENGER COMPARTMENT TRIM.<br>TAIL PIPE MUST HAVE ADEQUATE SPACE TO FUEL TANK |

| | |
|---|---|
| 14. CHECK SYSTEM ALIGNMENT | 1. POSITION SYSTEM CLEAR OF FRAME, SPRINGS, AND SHOCKS<br>2. TORQUE "U" CLAMPS TO SPECIFICATIONS |
| 15. CHECK EXHAUST SYSTEM LEAKS | 1. LOWER VEHICLE<br>2. REPLACE BATTERY GROUND<br>3. START VEHICLE<br>4. CHECK ALL SLIP JOINTS FOR LEAKS<br>NOTE: CORRECT ANY LEAKS OR RATTLES PRESENT AT THIS TIME<br>5. REMOVE FENDER COVERS AND CLOSE HOOD<br>6. PARK VEHICLE IN APPROVED PARKING AREA, WIPE STEERING WHEEL AND REMOVE COVER FROM SEAT |
| 16. CLEAN WORK STATION | 1. AS IN PREVIOUS TASKS |

## III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS PRACTICE ON THEIR OWN USING JOB AND TASK SHEETS.
2. OBSERVE AND RETEACH AS NEED ARISES.
3. CHECK STUDENTS ON KEY POINTS.
4. HAVE STUDENTS PERFORM TASK AND GIVE KEY POINTS.

## IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS' ABILITY)

1. PUT STUDENTS ON THEIR OWN TO PERFORM TASK. (PERFORMANCE TEST)

## V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKINGS STANDARDS. THIS SUMMARY MAYBE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. EMPHASIZE SAFETY WORK HABITS
2. REVIEW STEP BY STEP PROCEDURE IN EXHAUST SYSTEM INSPECTION
3. REVIEW PROPER REMOVAL AND INSTALLATION OF MUFFLER, EXHAUST PIPE, AND TAIL PIPE
4. REVIEW FINAL INSPECTION OF WORK

SUGGESTED READING FOR THE STUDENTS:

AUTOMECHANICS, PP. 39-50
AUTOMOTIVE ENCYCLOPEDIA, PP. 299-303
AUTO SERVICE AND REPAIR, CH. 33

THE NEXT LESSON IS: IX-A-1(S) "AIR CONDITIONING DIAGNOSIS"

VIII-C-25(J)

# JOB SHEET
# ON
# EXHAUST SYSTEM SERVICE

| | |
|---|---|
| JOB: | RECONDITION EXHAUST SYSTEM |
| MATERIALS: | GASKETS, SEALER, CLEAN RAGS, PENETRATING OIL, NEW PIPES, MUFFLER, CLAMPS, AND HANGERS |
| TOOLS AND EQUIPMENT: | BASIC HAND TOOLS, DROP LIGHT, FLOOR HOIST OR JACK, SAFETY STANDS, SAFETY GOGGLES, CLEAN SEAT AND FENDER COVERS, TORQUE WRENCH, TUBING CUTTER, HACKSAW, PIPE EXPANDER, WIRE BRUSH, PNEUMATIC CUTTER WITH ATTACHMENTS (OPTIONAL) |
| GENERAL INSTRUCTIONS: | WEAR EYE PROTECTION, BE ALERT AND WORK SAFELY. USE REFERENCE MATERIALS AS NEEDED. ASK QUESTIONS. PERFORM EACH STEP IN SEQUENCE. FOLLOW INSTRUCTIONS. |
| PROCEDURES AND/OR TASKS: | VIII-C-23(TS) POSITION AND PREPARE VEHICLE<br>VIII-C-25(TS) PRE-INSPECTION AND REPAIR<br>VIII-C-25a(TS) REMOVE EXHAUST ASSEMBLY<br>VIII-C-25b(TS) INSTALL EXHAUST SYSTEM |
| CHECK POINTS: | HAVE INSTRUCTOR CHECK EACH PROCEDURE DURING PERFORMANCE OF TASK |

## TASK SHEET VIII-C-25(TS)

**TASK:** PRE-INSPECTION AND REPAIR

**JOB:** RECONDITION EXHAUST SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** BASIC HAND TOOLS, DROP LIGHT, FLOOR HOIST OR JACK, SAFETY STANDS, SAFETY GOGGLES, CLEAN SEAT AND FENDER COVERS, TUBING CUTTER, (PNEUMATIC CUTTER WITH ATTACHMENTS-OPTIONAL) WIRE BRUSH, PENETRATING OIL, HACKSAW, CLEAN RAGS

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 2. PREPARE VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 3. CHECK EXHAUST AND BODY OPENINGS | 1. VISUALLY INSPECT EXHAUST PIPE, MUFFLER, AND TAIL PIPE<br>a. LOOSE CLAMPS AND CONNECTIONS<br>b. CRACKS AND RUST SPOTS<br>c. POSITIONING<br>d. NEEDED REPAIRS<br>2. VISUALLY INSPECT UNDERBODY<br>a. HEAT BAFFLES<br>b. OPEN SEAMS<br>c. OPEN SEAMS<br>d. TRUNK LID FIT<br>NOTE: MAKE ANY REPAIRS, AT THIS TIME, TO CORRECT ANY DANGEROUS CONDITION THAT COULD LET EXHAUST FUMES INTO PASSENGER COMPARTMENT THROUGH OPENINGS IN UNDERBODY. MAKE NEEDED CORRECTIONS TO PIPE ROUTING WHEN NEW PARTS INSTALLED<br>3. SOAK ALL BOLTS AND NUTS WITH PENETRATING OIL<br>4. CLEAR WORK AREA OF ANY TRASH |

## TASK SHEET

VIII-C-25a(TS)

**TASK:** REMOVE EXHAUST ASSEMBLY

**JOB:** RECONDITION EXHAUST SYSTEM

**TRADE:** AUTOMECHANICS

**TOOLS AND MATERIALS:** AS PER TASK VIII-C-25(TS)

**TASK BREAKDOWN:**

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 2. PREPARE VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 3. LOOSEN EXHAUST | 1. LOOSEN "U" BOLTS AND CLAMPS HOLDING TAIL PIPE TO HANGER AND MUFFLER |
| | 2. LOOSEN "U" BOLTS AND CLAMPS HOLDING MUFFLER AND EXHAUST PIPE |
| | 3. LOOSEN EXHAUST PIPE-MANIFOLD ATTACHING NUTS<br>NOTE: LOOSEN NUTS ONLY, DO NOT REMOVE AT THIS TIME |
| 4. REMOVE TAIL PIPE | 1. REMOVE TAIL PIPE ATTACHING NUTS |
| | 2. POSITION CUTTING TOOL AT REAR OF MUFFLER |
| | 3. SPLIT MUFFLER OUTLET NIPPLE ON OPPOSITE SIDES<br>CAUTION: IF TAIL PIPE ONLY IS BEING REPLACED, BE CAREFUL NOT TO CUT INNER PIPE |
| | 4. TWIST AND PULL PIPE TO LOOSEN |
| | 5. SLIDE TAIL PIPE REARWARD AND LIFT FROM MUFFLER |
| 5. REMOVE MUFFLER | 1. REMOVE FRONT CLAMP |
| | 2. SPLIT MUFFLER INLET NIPPLE WITH CUTTER<br>NOTE: OBSERVE CAUTIONS WHEN CUTTING |
| | 3. TWIST AND PULL MUFFLER TO LOOSEN ON EXHAUST PIPE |
| | 4. SLIDE MUFFLER FROM EXHAUST PIPE END |

| STEPS | KEY POINTS |
|---|---|
| 6. REMOVE EXHAUST PIPE | 1. REMOVE EXHAUST PIPE TO MANIFOLD ATTACHING NUTS |
| | 2. MOVE EXHAUST PIPE IN BACK AND FORTH MOTION WHILE TWISTING TO LOOSEN PIPE IN MANIFOLD |
| | 3. LIFT EXHAUST PIPE FROM EXHAUST MANIFOLD |
| 7. CLEAN WORK AREA | 1. DISPOSE OF OLD PARTS REMOVED FROM EXHAUST SYSTEM |
| | 2. SWEEP UP TRASH AND DIRT |
| | 3. WIPE TOOLS AND PLACE READY FOR USE |

## TASK SHEET

VIII-C-25b(TS)

TASK: INSTALL EXHAUST SYSTEM

JOB: RECONDITION EXHAUST SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: BASIC HAND TOOLS, DROP LIGHT, TORQUE WRENCH, FENDER AND SEAT COVERS, SAFETY GOGGLES, CLEAN RAGS, HOIST OR FLOOR JACK, SAFETY STANDS, PIPE SPREADER, AND NEW PARTS

TASK BREAKDOWN:

| STEPS | KEY POINTS |
|---|---|
| 1. POSITION VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 2. PREPARE VEHICLE | 1. AS PER TASK VIII-C-23(TS) |
| 3. PRE-INSPECTION AND REPAIR | 1. AS PER TASK VIII-C-25(TS) |
| 4. REMOVE EXHAUST ASSEMBLY | 1. AS PER TASK VII-C-25a(TS) |
| 5. PREPARE NEW PARTS | 1. INSTALL PIPE EXPANDER IN PIPE ENDS OR MUFFLER NIPPLES IF NEEDED<br>2. TIGHTEN PIPE EXPANDER IN PIPE ENDS OR MUFFLER NIPPLES TO REMOVE BENDS OR DENTS<br>3. CHECK PIPE AND MUFFLER FIT TO INSURE CORRECT FITTING AND EASY INSTALLATION |
| 6. INSTALL EXHAUST PIPE | 1. INSTALL NEW EXHAUST FLANGE GASKET (IF REQUIRED)<br>2. POSITION NEW EXHAUST PIPE IN EXHAUST MANIFOLD OUTLET<br>3. INSTALL NEW EXHAUST PIPE ATTACHING NUTS<br>NOTE: DO NOT TIGHTEN AT THIS STAGE |
| 7. INSTALL MUFFLER | 1. APPLY EXHAUST SYSTEM SEALER TO MUFFLER INLET AND OUTLET NIPPLES<br>2. SLIDE MUFFLER INTO POSITION ON EXHAUST PIPE<br>3. INSTALL "U" CLAMP ON INLET NIPPLE AND TIGHTEN WITH FINGERS |

| STEPS | KEY POINTS |
|---|---|
| 8. INSTALL TAIL PIPE | 1. APPLY EXHAUST SYSTEM SEALER TO TAIL PIPE SLIP JOINT<br>2. POSITION TAIL PIPE IN HANGERS AND MUFFLER OUTLET NIPPLE<br>3. SLIDE TAIL PIPE INTO MUFFLER OUTLET NIPPLE<br>4. INSTALL "U" CLAMPS AND TIGHTEN WITH FINGERS |
| 9. ALIGN MUFFLER AND PIPES | 1. SEAT MUFFLER FIRMLY ON EXHAUST PIPE OUTLET AND TIGHTEN "U" CLAMP<br>2. ALIGN AND SEAT TAIL PIPE END INTO MUFFLER OUTLET NIPPLE<br>3. HOLD TAIL PIPE IN POSITION AND TIGHTEN MUFFLER REAR "U" CLAMPS<br>4. POSITION TAIL PIPE IN HANGERS AND TIGHTEN "U" CLAMPS<br>5. TIGHTEN EXHAUST PIPE TO MANIFOLD ATTACHING NUTS |
| 10. CHECK FLOOR CLEARANCE | 1. CHECK EXHAUST PIPE TO FRAME CLEARANCE<br>2. CHECK MUFFLER TO FLOOR PAN<br>3. CHECK TAIL PIPE TO FLOOR PAN AND FUEL TANK CLEARANCE<br>CAUTION: EXHAUST SYSTEM COMPONENTS MUST HAVE ADEQUATE CLEARANCE FROM FLOOR PAN TO AVOID POSSIBLE OVERHEATING AND DAMAGE TO PASSENGER OR TRUNK COMPARTMENT TRIM. TAIL PIPE MUST HAVE ADEQUATE SPACING AT FUEL TANK |
| 11. CHECK SYSTEM ALIGNMENT | 1. POSITION MUFFLER AND PIPE CLEAR OF FRAME, SPRINGS, BODY, AND SHOCKS<br>2. TIGHTEN ALL "U" CLAMPS AND NUTS TO SPECIFICATIONS |
| 12. CHECK EXHAUST | 1. LOWER VEHICLE<br>2. REPLACE BATTERY GROUND<br>3. START ENGINE<br>4. CHECK ALL PIPE CONNECTIONS FOR LEAKAGE<br>NOTE: CORRECT ANY LEAKS OR RATTLES NOTED AT THIS STAGE |

| STEPS | KEY POINTS |
|---|---|
| 13. SECURE VEHICLE | 1. REMOVE FENDER COVERS AND CLOSE HOOD<br>2. WIPE VEHICLE CLEAN OF ANY OIL, GREASE, OR HAND PRINTS<br>3. PARK VEHICLE IN APPROVED PARKING AREA<br>4. WIPE STEERING WHEEL WITH CLEAN RAG AND REMOVE SEAT COVERING |
| 14. CLEAN WORK STATION | 1. CLEAN TOOLS AND EQUIPMENT AND TURN TO STORAGE<br>2. DISPOSE OF ALL TRASH<br>3. CLEAN WORK BAY AND WORK BENCH |